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Atlantic salmon (*Salmo salar*) overview for eastern Cape Breton, Eastern Shore, Southwest Nova Scotia and inner Bay of Fundy rivers (SFA 19 to 22) in 2005

Aperçu de la situation du saumon atlantique (*Salmo salar*) de l'est du Cap-Breton, de la côte est et du sud-ouest de la Nouvelle-Écosse, ainsi que des cours d'eau du fond de la baie de Fundy (ZPS 19 à 22) en 2005

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FOREWORD

This document is a product from a workshop that was not conducted under the Department of Fisheries Oceans (DFO) Science Advisory Process coordinated by the Canadian Science Advisory Secretariat (CSAS). However, it is being documented in the CSAS Research Document series as it presents some key scientific information related to the advisory process. It is one of a number of contributions first tabled at a DFO-SARCEP (Species at Risk Committee / *Comité sur les espèces en péril*) sponsored workshop in Moncton (February 2006) to begin the development of a 'Conservation Status Report' (CSR) for Atlantic salmon. When completed in 2007, the CSR could form the basis for a Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status report, recovery potential assessment and recovery strategy, and most importantly, enable DFO to implement pre-emptive management measures prior to engagement in any listing process.

AVANT-PROPOS

Le présent document est issu d'un atelier qui ne faisait pas partie du processus consultatif scientifique du ministère des Pêches et des Océans, coordonné par le Secrétariat canadien de consultation scientifique (SCCS). Cependant, il est intégré à la collection de documents de recherche du SCCS car il présente certains renseignements scientifiques clés, liés au processus consultatif. Il fait partie des nombreuses contributions présentées au départ lors d'un atelier parrainé par le MPO-SARCEP (*Species at Risk Committee* / Comité sur les espèces en péril) à Moncton (février 2006) en vue de commencer l'élaboration d'un rapport sur la situation de la conservation du saumon atlantique. Lorsqu'il sera terminé, en 2007, ce rapport pourrait servir de base à un rapport de situation du Comité sur la situation des espèces en péril au Canada (COSEPAC), à une évaluation du potentiel de rétablissement et à un programme de rétablissement mais, avant tout, il permettra au MPO de mettre en œuvre des mesures de gestion anticipées avant même de s'engager dans un processus d'inscription.

Abstract

The status of Atlantic salmon populations in rivers in Eastern Cape Breton Island (SFA 19), along the Nova Scotia Eastern Shore (SFA 20), in Southwest Nova Scotia (SFA 21) and in part of the inner Bay of Fundy (SFA 22) is presented in this document. In eastern Cape Breton, both the number of salmon returning to the rivers and the spawning escapements were generally below the conservation requirements in 2005. However, the number of returning adults in 2005 was slightly higher than both the number of returns in 2004 and the previous 5-year mean. Overall, population status in this region is better than in rivers on mainland Nova Scotia's Atlantic Coast and the Bay of Fundy. Returns and escapements to the Southern Uplands region (SFA 20 and 21) were insufficient to meet conservation requirements in 2005. Wild salmon populations are currently at critically low abundance levels, especially in rivers with medium to high acidity. Population enhancement projects have been terminated as of 2005, and management has shifted focus to protecting remnant wild populations in ways that maintain their genetic fitness. Inner Bay of Fundy salmon populations are designated as "Endangered" by COSEWIC. Populations in SFA 22 are presently not viable and remnant populations are being maintained through the Live Gene Bank program.

Résumé

Le document expose l'état des populations de saumon atlantique dans les cours d'eau de l'est de l'île du Cap-Breton (ZPS 19), de la côte est de la Nouvell-Écosse (ZPS 20), du sud-ouest de la Nouvelle-Écosse (ZPS 21) et d'une partie du fond de la baie de Fundy (ZPS 22). Dans l'est du Cap-Breton, le nombre de saumons qui retournent dans leur cours d'eau d'origine et l'échappée de géniteurs étaient tous deux généralement inférieurs aux impératifs de conservation pour 2005. Toutefois, le nombre de retours d'adultes en 2005 était légèrement plus élevé que le nombre de retours en 2004 et que la moyenne antérieure sur cinq ans. Dans l'ensemble, l'état de la population dans cette région est meilleur que celle des cours d'eau de la côte atlantique le long de la partie continentale de la Nouvelle-Écosse et de la baie de Fundy. Les retours et l'échappée vers la région des hautes-terres du sud (ZPS 20 et 21) étaient insuffisants pour atteindre les impératifs de conservation en 2005. Les populations de saumon sauvages sont actuellement à un niveau d'abondance dangereusement bas, surtout dans les rivières dont le taux d'acidité est de moyen à élevé. Les projets de mise en valeur des populations se sont terminés en 2005 et les mesures de gestion sont maintenant orientées vers la protection du reliquat des populations sauvages en vue de maintenir leur intégrité génétique. Les populations de saumon du fond de la baie de Fundy ont été désignées comme étant « en danger de disparition » par le COSEPAC. Les populations de la ZPS 22 ne sont actuellement pas viables et les populations reliques sont maintenues à l'aide du programme de la banque de gènes vivants.

Introduction

This document contains an assessment of the status of Atlantic salmon populations in four Salmon Fishing Areas (SFA's) in Nova Scotia (Figure 1), including Eastern Cape Breton Island (SFA 19), the Eastern Shore (SFA 20), Southwest Nova Scotia (SFA 21) and part of the inner Bay of Fundy population complex (SFA 22). The last formal assessment was completed in 2003 for Eastern Cape Breton (Robichaud-LeBlanc & Amiro, 2004), in 1999 for the Southern Uplands (Amiro et al. 2000) and in 2003 for the inner Bay of Fundy (Gibson et al. 2004).

In general, water quality in the river systems of Eastern Cape Breton (SFA 19) is better for Atlantic salmon than that in the other SFAs, and the habitat is the least impacted by human activities. While some populations have undergone declines, salmon abundance in some rivers of SFA 19 have remained relatively stable for the last decade. SFA 19 supports the largest recreational fisheries in the Scotia-Fundy region. The Eastern Shore (SFA 20) and Southwest Nova Scotia (SFA 21) are collectively known as the Southern Upland region of Nova Scotia. In contrast with Eastern Cape Breton, salmon productivity in the Southern Upland has been impacted by acidification and large population declines have been recorded in some rivers within the last decade. The current recreational fishery is small and, until recently, has been maintained in some rivers through supplementation of populations by stocking hatchery-reared smolts. In the inner Bay of Fundy region (SFA 22 and part of SFA 23) Atlantic salmon populations are at critically low levels. As a result, they have been designated "Endangered" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and have been listed for legal protection under the Species At Risk Act (SARA). There is no recreational fishery for salmon in the inner Bay of Fundy.

The status of salmon populations within each SFA are assessed using indices developed from a combination of approaches, including fishery-dependent adult counts, fishery-independent adult or smolt counts, and juvenile density estimates from electrofishing surveys. Adult salmon are classified into two size categories for management purposes, those < 63.0 cm fork length are termed "small" and those ≥ 63.0 cm are termed "large". Small salmon return to their natal river after one winter at sea (1SW) and large salmon return after multiple winters (MSW). In each SFA, certain rivers have been chosen for long-term monitoring purposes and to various degrees have been shown to be indicative of trends throughout the region (O'Neil et al. 1998).

The purpose of this document is to summarize the monitoring activities conducted in each SFA during 2005 and to evaluate trends in the status of Atlantic salmon populations both within and among regions. Potential threats to population persistence are discussed relative to current management practices and conservation goals.

Eastern Cape Breton Island – SFA 19

Salmon population monitoring in Eastern Cape Breton Island is focused on four major river systems: Middle, Baddeck, North and Grand (Figure 2). Of these, the Grand River has the lowest mean stream gradient, and its seasonal water flow and temperature are influenced by mid-reach lakes (Robichaud-LeBlanc & Amiro 2004). The remaining three rivers originate in small headwater lakes in the Cape Breton Highlands and are characterized by steeper stream gradients as well as relatively pristine water quality. Over 80% of the annual recreational fishing effort in Eastern Cape Breton takes place on the above four rivers (Table 1).

Adult assessments in SFA 19 are based on recreational catches, which are reported through a license-stub return program, as well as fishery-independent counts of salmon by surface divers, where observation efficiency is estimated through mark-recapture calibration. The autumn dive counts have been conducted annually on the Middle River since 1989 and on the Baddeck and North rivers since 1994 (Amiro & Longard 1995, Marshall et al. 1998). Dive counts are not done on the Grand River because of inadequate water clarity. Each section is swum once during autumn, although the specific dates vary from year to year according to stream conditions. When water levels are low enough to permit the seining of pools, streamer tags are applied to adults netted in the week prior to the dive. Divers record the number of small and large salmon seen, as well as the number of marked individuals. Abundance is estimated using Peterson's method for mark-recapture data. In years when

streamer tags are not applied, abundance is estimated using the average observation rate calculated in years when tags are applied (Robichaud-LeBlanc & Amiro 2004). An annual observation rate is calculated by dividing the total number of salmon seen by divers by the Peterson estimate of total population size for the same year.

The Department of Fisheries and Oceans (DFO) has not assessed juvenile salmon abundance in SFA 19 since 2002. The results from past juvenile sampling surveys (1996 – 2002) are presented in Robichaud-LeBlanc & Amiro (2004).

Middle River

Habitat

The main stem of the Middle River, Victoria County, arises in the Cape Breton Highlands, about 450 m above sea level (Figure 3). From there, it flows in a southward direction to its confluence with Nyanza Bay, in the St. Patrick's Channel of the Bras d'Or Lakes. Throughout its length, Middle River is unobstructed and is not impacted by acid precipitation, but is exposed to agricultural practices in the lower valley (Marshall et al. 2000).

Biological characteristics

Salmon in the Middle River generally spend 2 years in freshwater and undergo smoltification after their second winter. Less than 30% of the population matures as 1SW adults, leading to a run composed primarily of large salmon (Marshall et al. 1998). There is some indication that the proportion of MSW salmon in the population has declined in recent years (Marshall et al. 2000). The current population returns to spawn in autumn (Marshall et al. 1997); the component of the population which returned to the river during summer has disappeared in recent years (Marshall et al. 2000). The wild population has been impacted by stocking projects for recreational fishery enhancement (prior to 1995) and has come into contact with hatchery escapees from grow-out sites on the Bras D'Or Lakes (Marshall et al. 2000). There is currently no stocking of hatchery-reared salmon in this system.

Recreational fishery

Since 1998, the recreational salmon fishery on Middle River has been limited to catch and release fishing exclusively, within June 1 – July 15 and September 1 – October 31 (shortened season). Previous to 1998, the fishing season was continuous from June 1 – October 31 (full season). Anglers spent an estimated 458 rod-days on the Middle River in 2005. This was approximately 2.5 times higher than 185 rod-days in 2004 and was double the previous 5-year mean of 231 rod-days (Table 1).

Status

Adult salmon returns and escapement (returns - removals) to Middle River in 2005 were estimated by two methods: (1) from a dive count, where the observation rate is assumed to be equal to the mean observation rate during years when mark-recapture (MR) experiments were conducted, and (2) from the recreational catch, where the catch rate is assumed to be equal to the mean catch rate during 1994-2004. Escapements in 2005 were estimated after accounting for losses of salmon from the river system due to angling retention and mortality.

The angling catch of both small and large salmon was high in 2005 relative to recent years, estimated at 44 and 128 individuals respectively (Table 2). For small salmon, this was nearly double the mean of the previous 5-year period (44 fish as compared to 21) while the catch of large salmon was slightly greater than double the 5-year mean (128 fish as compared to 60). Mean catch rates (1994 – 2005) were estimated at 0.28 (90% CI = 0.21, 0.34) and 0.42 (90% CI = 0.33, 0.52) for small and large salmon respectively, which would predict total returns of 103 (90% CI = 85, 131) small and 462 (90% CI = 374, 604) large salmon to the Middle River in 2005 (Figure 4). Mortality resulting from recreational catch and release fishing was assumed to be 3% for the shortened season. Therefore, removals of adults from the system (including those due to angling mortality) were relatively low, estimated at 1 small and 4 large salmon in 2005 (Table 2).

During the dive count on November 2, 2005, a total of 274 salmon were observed within the 6 sections swum on Middle river. Adverse water conditions prohibited the seining of pools, so counts were conducted on an unmarked population (Appendix 1). Based on previous mark-recapture experiments and subsequent estimates of annual observation rates (Robichaud-LeBlanc & Amiro 2004), it was estimated that 61% (90% CI = 50, 71) of the actual escapement was observed during a survey. Therefore, total returns were estimated to be 456 salmon, and estimated escapement was 451 fish, of which 20% were small. Overall, escapement was 17% greater than in 2004, and was comprised of 94 (90% CI = 80, 113) small and 357 (90% CI = 305, 430) large salmon (Figure 4).

Conservation requirement

The conservation requirement for Middle River, 2.07 million eggs, was calculated based on an estimated 864,600 m^2 of available spawning habitat and a target egg deposition density of 2.4 eggs/m^2 (Marshall et al. 2000). Based on estimates of mean fecundity by size class and the ratio of small to large salmon in the population in Middle River (Marshall et al. 2000), escapements of 470 large and 80 small salmon are thought to be sufficient to meet the conservation requirement. In 2005, small salmon escapement was estimated to be approximately 117% of the requirement (94 fish), while large salmon escapement was estimated to be approximately 76% of the requirement (357 fish). The combined achievement was approximately 82%. Escapements of both large and small salmon were higher than in 2004 (Figure 4), yet were similar to the previous 5-year means.

Baddeck River

Habitat

The headwaters of the Baddeck River, Victoria County, are located in the Cape Breton Highlands, about 430 m above sea level (Figure 5). From there, the river flows southwest to its confluence with Nyanza Bay, in St. Patrick's Channel of the Bras d'Or Lakes. The river mouth is less than 4 km east of the mouth of Middle River (Figure 2). The Baddeck River is unobstructed and is not impacted by acid precipitation, but has increased sedimentation rates due to agriculture (Marshall et al. 2000). The gradient profile of the Baddeck River is steeper than that of Middle River (Robichaud-LeBlanc & Amiro 2004), which results in proportionately more suitable habitat available for juvenile salmon production (Amiro 1993).

Biological Characteristics

As was the case in Middle River, there is no longer a summer run of Atlantic salmon to the Baddeck River, and adults only return to spawn in autumn. Stocking of smolts originating from the North River population in the mid 1980s did not help to re-establish the summer-run component of the population (Marshall et al. 1997). There is currently no stocking of hatchery-reared salmon in this river system. The majority of adults spend two winters at sea before ascending the river in autumn to spawn, and most juveniles undergo smoltification after two years in fresh water.

Recreational Fishery

The recreational fishery on the Baddeck River has the same regulations as the one on Middle River (catch and release only) and has the same annual season (June 1 – July 15 and September 1 – October 31). Anglers spent an estimated 397 rod-days on the Baddeck River in 2005. This was more than double the 185 rod-days in 2004 and the previous 5-year mean of 185.4 rod-days (Table 1).

Status

Adult salmon returns and escapement (returns - removals) to Baddeck River in 2005 were estimated using the same two methods as for the Middle River. River-specific catch rates (angling catch divided by a Peterson estimate of total returns) and observation rates (diver counts divided by a Peterson estimate of total escapement) were estimated based on data collected during 1994-2005. Mortality rates from angling were assumed to be 5% of the released catch for the full season (prior to 1998) and 3% for the shortened season (1998 onwards).

Similar to Middle River, the estimated angling catch of 48 small and 131 large salmon in 2005 was higher than the 2004 estimates (Table 3). This was nearly 3 times higher than the previous 5-year mean catch of 16 small salmon, and was over 2.5 times higher than the 5-year mean catch of 131 large salmon. Mean angling catch rates (1994-2005) were estimated to be 0.57 (90% CI = 0.38, 0.77) for small and 0.38 (90% CI = 0.27, 0.50) for large salmon, which predicted total returns of 84 (90% CI = 62, 127) small and 341 (90% CI = 263, 484) large salmon to Baddeck River in 2005. Given that mortality due to recreational fishing was assumed to be 3% in 2005, estimated removals of adult salmon were relatively low, at 1 small and 4 large (Table 3).

During dive counts on November 1, 2005 (Figure 5), a total of 155 salmon were observed (Appendix 1). Adverse water conditions prohibited the seining of pools, so counts were conducted on an unmarked population. Based on previous mark-recapture experiments and the average observation rate in years when fish were marked (Robichaud-LeBlanc & Amiro 2004), it was estimated that approximately 56% of the actual escapement was observed by divers during the 2005 survey. Therefore, estimated wild returns and escapements were 283 and 277 salmon respectively, of which 21.9% were small. Overall, escapement was 177% greater than in 2004, and was comprised of 61 (90% CI = 47, 84) small and 216 (90% CI = 169, 300) large salmon (Figure 6).

Conservation requirement

The conservation requirement for Baddeck River, 2.0 million eggs, was calculated based on an estimated 836,300 m^2 of available spawning habitat and a target egg deposition density of 2.4 eggs/m^2 (Marshall et al. 2000). Given the estimated mean fecundity by size class and the proportion of small to large salmon in the Baddeck River population (Marshall et al. 2000), escapements of 450 large and 80 small salmon are thought to be sufficient to meet the conservation requirement. In 2005, the estimated escapements of small and large salmon were 76% (61 fish) and 48% (216 fish) of the requirement, respectively (Figure 6). The weighted combined attainment was 52% of the target escapement, yet was 62% above the previous 5-year mean.

North River

Habitat

The North River, Victoria County, runs along the eastern slope of the Cape Breton Highlands (Figure 2). The river originates about 475 m above sea level and travels approximately 30 km to St. Ann's Harbour in the Atlantic Ocean. Gradients are steep, with many small falls and several barriers to upstream fish passage in the upper portion of the river. In terms of salmon production, water quality is good and the river had not been impacted by acid precipitation or agricultural practices (Amiro & Marshall 1990). Based on stream gradient profiles, the North River contains the largest area of habitat suitable for juvenile salmon production of the rivers in SFA 19 (Amiro 1993).

Biological Characteristics

The adult spawning stock is predominantly summer-run and it contains a high proportion of large (MSW) salmon (O'Connell et al. 1997). There is currently no stocking of hatchery-reared salmon in this system, although escapes from aquaculture sites in the Bras D'Or Lakes occasionally enter the river (Marshall et al. 2000).

Recreational Fishery

The recreational fishery on the North River is open downstream from "The Benches" on the main stem (Figure 7) to catch and release only with a season of June 1-Oct. 31 (full season). The area upstream, including the West Branch, is closed to angling all year. Overall, anglers spent an estimated 441 rod-days on the North River in 2005. This was 14% less than the 505 rod-days in 2004, but was 21% greater than the previous 5-year mean (Table 1).

Status

Adult salmon returns and escapement (returns - removals) to North River in 2005 were estimated from recreational catches and the mean catch rate derived for this river. Mortality rates from angling were assumed to be 5% of the released catch. Although population estimation based on mark-recapture dive counts was completed from 1994 – 1998, marking has not been possible in recent years (1999 - 2005). Furthermore, adverse water conditions have prohibited diver counts during the same time period (1999 - 2005) except for July 2001, October 2002, and October 2004. In 2004, only pools in section 1 of the river (Figure 7) were surveyed, although the usual reaches were swum in the lower sections (Appendix 1). The river was not surveyed by divers in 2005. Given that escapement estimates from recreational angling catches are generally higher than those derived from diver counts (Robichaud-LeBlanc & Amiro 2004, this document), it is possible that returns to the North River in 2005 are overestimated.

The estimated angling catch of both small and large salmon was high in 2005, at 52 and 168 individuals respectively (Table 4). Compared with the previous 5-year mean, the angling catch of small salmon was very similar to that in 2005 (52 fish as compared to 51.6), while the catch of large salmon was slightly less than double the 5-year mean (168 fish as compared to 90). Mean angling catch rates (1994-2005) were estimated to be 0.84 (90% CI = 0.38, 1.30) and 0.47 (90% CI = 0.25, 0.69) for small and large salmon respectively, which would predict total returns of 62 (90% CI = 40, 137) small and 361 (90% CI = 245, 683) large salmon to North River in 2005. Removals (due to angling mortality) of adults from the system were relatively low, estimated at 2 small and 5 large salmon (Table 4).

Conservation requirement

The conservation requirement for North River, 0.85 million eggs, was calculated based on an estimated 382,700 m^2 of available spawning habitat and a target egg deposition density of 2.4 eggs/m^2 (Marshall et al. 2000). Accounting for individual fecundity and the proportion of small to large adults in the population (Marshall et al. 2000), annual escapements of 30 small and 200 large salmon would be sufficient to meet the conservation requirement. In 2005, escapements of small and large salmon were approximately 2 times and 1.8 times greater than the target number, respectively. The weighted combined attainment was approximately double the conservation requirement (Figure 8). However, it is important to note that escapement estimates based on the recreational catch were high relative to those based on dive surveys for both the Middle and Baddeck Rivers in 2005, and therefore may be over-estimated for the North River as well.

Grand River

Habitat

The Grand River watershed, Richmond County, drains approximately 217 km^2 of total land area (Amiro & Longard 1990). Its main stem flows in a southerly direction from Loch Lomond Lake to its confluence with the Atlantic Ocean (Figure 2). The Grand River is characterized by a low stream gradient, declining approximately 100 m in elevation over the course of its 15.7 km length (Marshall et al. 2000). During periods of low discharge, Grand River Falls, which is located 10.2 km upstream of head-of-tide, obstructs salmon passage (Figure 9). About 45% of the total juvenile production potential of Grand River is estimated to be upstream of the falls, while 55% is below (Amiro & Longard 1990). Of the adults found upstream of the falls, Amiro and Longard (1990, 1995) found that approximately 60% of small and 40% of large salmon used the fishway while the rest were presumed to have ascended the falls. Salmon movements at the fishway have not been monitored since 2000. However, to ensure that results are comparable with previously reported data, only returns and escapement above the fishway are estimated.

Biological Characteristics

In contrast to many other Cape Breton stocks, the salmon population in the Grand River is characterized by a high proportion of small (1SW) salmon; the few large fish tend to be repeat-spawning 1SW individuals. Adults return to the river early, typically in late June or early July (Robichaud-Leblanc & Amiro 2004). There is currently no stocking of hatchery-reared salmon in this system, and no hatchery contribution to adult returns has been recorded since 1999 (DFO 2001).

Recreational Fishery

The recreational fishery on the Grand River has the same regulations as the ones on the Baddeck and Middle Rivers (catch and release only) and has the same shortened annual season (June 1 – July 15 and September 1 – October 31). Anglers spent an estimated 13 rod-days on the Grand River in 2005. This was approximately one-half of the effort expended in 2004 (13 as compared with 35 rod-days), and was more than a four-fold decrease from the previous 5-year mean (Table 1).

Status

Grand River has not been monitored by fishery-independent methods since 2000, and as a result, adult returns and escapement (returns + removals) in recent years have been estimated from recreational catches (assuming a catch rate of 0.5) exclusively. Mortality due to recreational catch and release fishing was estimated to be 4% of the released catch from 1998 onwards (shortened season) and 7% prior to 1998 (full season).

The angling catch in 2005 consisted of 15 small and 0 large salmon, from which total returns were estimated to be 30 small and 0 large individuals (Table 5). Given the relative scarcity of large salmon, the two size categories were combined for monitoring purposes. Total returns in 2005 (30 fish) were nearly double those in 2004 (18 fish) and were 30% lower than the previous 3-year mean (data is not available from 2000 and 2001). Removals (due to angling mortality) of adults from the system were extremely low, estimated at 1 small salmon (Table 5).

Conservation requirement

The conservation requirement for Grand River, 1.1 million eggs, was calculated based on an estimated 461,800 m^2 of available spawning habitat and a target egg deposition density of 2.4 eggs/m^2 (Marshall et al. 2000). Total returns of 545 salmon are necessary to meet the conservation requirement, and 234 of these individuals would have to pass through the fishway. In 2005, total escapement above the fishway was the third lowest value in the dataset, at 30 fish (Figure 10). During the last four years (2002-2005), returns have averaged 38 fish, which is only 16% of the conservation requirement.

Overall trends

On the basis of estimated adult escapement, conservation requirements were generally not achieved in the monitored rivers of Eastern Cape Breton in 2005. However, there is some indication that escapements may be above the requirements for the North River. The adult returns in 2005 were generally higher than those in 2004 for all rivers surveyed. Only returns on the North River may remain above the conservation requirement. However, a comparison between fishery-independent and fishery-dependent estimation procedures suggest that returns to the North River may have been overestimated in 2005. Adult returns are below conservation requirements on Middle and Baddeck, and it is unlikely that these rivers will consistently meet or exceed conservation requirements in the near future. Meeting or exceeding conservation requirements on the Grand River in the near future is very unlikely.

Southern Uplands – SFAs 20 and 21

Rivers draining the coastal plain known as the Southern Upland (Roland 1982), generally pass through lowlands characterized by shallow soils or peat bogs underlain by granite and other metamorphic rocks (Watt 1987). As a result, water is generally organic-acid-stained and the system is less productive than more mineral-rich rivers. When such waters are influenced by acid precipitation, conditions can become toxic for Atlantic salmon (LaCroix 1985). At a mean annual pH below 5.1, salmon production is considered unstable and only remnant populations may persist. Interspersed within the Southern Uplands are limestone-rich soils (drumlins) which provide local regions of less-acidified water.

As of 1986, fourteen rivers in SFA 20 and eight rivers in SFA 21 were classified as either low- or non-acidified (pH greater than 5.1) and were known to contain Atlantic salmon populations (the rivers had

historically been fished for Atlantic salmon). For assessment purposes, two of these rivers were chosen as index rivers for long-term monitoring (Amiro et al. 2000): the St. Mary's River in SFA 20 and the LaHave River (above Morgan Falls) in SFA 21. The status for most if not all low- or non-acidified rivers in SFA 20 and 21 is expected to be similar or worse than that of the index rivers (O'Neil et al. 1998, Amiro et al. 2000).

As of 1986, there were twenty rivers that were partially acidified (pH ranges from 4.7 - 5.0) and at least fourteen rivers that were heavily acidified (pH < 4.7). Despite reductions in sulphate deposition (acid precipitation) in recent years, the pH in Southern Upland rivers has not recovered at rates observed in other geographic areas (Watt 1987). Hydroelectric power facilities or impoundment for domestic water use have resulted in significant barriers to upstream migration and a loss of spawning habitat on 10 of the rivers in the Southern Upland region.

Based on electrofishing surveys done in 2000, juvenile salmon could not be found in 28 of 57 rivers sampled within the Southern Upland region. In addition, 16 of the 29 rivers with juvenile salmon had fewer than 5.0 juvenile salmon per 100 m^2 or 7% of a "normal" abundance (Figure 11). These data suggest that population extirpations have occurred and that most populations are critically low.

Eastern Shore – SFA 20

St. Mary's River

Habitat

The St. Mary's River consists of two branches (West and East) as well as a main stem that empties to the Atlantic Ocean at the town of Sherbrooke, Guysborough County, in Nova Scotia (Figure 12). The East Branch drains a series of lakes and streams originating in the Cobequid Highlands. The West branch drains the northern-most portion of the Southern Upland region. The East branch is less acidified than the West because the soils of the Cobequid Highlands are rich in base minerals. The course of the river system has changed significantly over geological time (Roland 1982), which has affected the distribution of salmon habitat as well as the productivity of the river.

Biological Characteristics

In the St. Mary's River, most Atlantic salmon juveniles spend two years in fresh water and migrate to sea as two-year-old smolts. Historically, adult returns in the system were characterized by a high proportion of 2SW (and some 3SW) salmon, of which approximately 60% were female (Marshall 1986). However, more recent assessments have shown significant increases in the proportion of adults maturing after one winter at sea (O'Neil & Harvie 1995). Length-fecundity relationships derived for the St. Mary's River (Amiro, unpublished data) show that 1SW fish have approximately one-half of the fecundity of MSW females.

Recreational fishery

Five rivers in SFA 20 were open to angling from June 1st to July 15th, 2005. Slightly more than 50% of the total fishing effort in SFA 20 took place on the St. Mary's River, and 17 % (13 fish) of the total recreational catch for this SFA came from the St. Mary's River. All were small salmon (Table 1). Anglers spent an estimated 119 rod-days on the St. Mary's River in 2005. This was slightly higher than 105 rod-days in 2004, but was below the previous 5-year mean of 181.1 rod-days. Similarly, catches were down from 39 small and 21 large salmon in 2004, and were more than 4 times lower in 2005 than the previous 5-year mean for both size categories (Table 1).

Adult Status

In the St. Mary's River prior to 1996, adult escapement estimates were derived from recreational catches and annual exploitation rates imported from the LaHave River (O'Neil et al. 1998). However, river-specific escapement estimates have been calculated since 1997. Mark-recapture experiments (to estimate abundance) were conducted in the St. Mary's River from 1997-2001, and were attempted without success

in 2002-2005. When this program was initiated, seining attempts were made at various sampling locations along both branches of the river, but sufficient marks and recaptures could only be obtained for salmon in the West Branch. More recently, efforts have focused on the West Branch exclusively. To scale up to the entire river, the West Branch estimate is divided by 0.55, which is the proportion of the amount of habitat available in the West Branch as compared to the total river (Amiro 1993, Amiro et al. 2000). The possibility that factors like water quality, discharge, substrate distribution etc. differentially affect habitat production capacities among the West Branch, East Branch and Main River is not accounted for in the relative production ratio based on habitat area.

During seining in 2005, a total of 1 large (MSW) fish and 26 small (1SW) salmon were captured, marked, and released back into the river (Table 6). The outward appearance of these fish suggested that they had been holding in the river for some time. Water levels had not increased substantially prior to seining, which would have considerably reduced the probability of additional adults moving into the river from the estuary. Therefore, it is possible that sampling took place before the total population of returning salmon was in the river. High water levels after the initial seining date precluded a second seining attempt to complete the mark-recapture experiment. Therefore, it was necessary to assume that the efficiency of the seining operation was equal to the mean catch rate for mark-recapture seining operations previously conducted at the same locations (1997-2001).

By multiplying the mean efficiency of 0.13 (90% CI = 0.06, 0.20) by the number of individuals captured through seining, estimated escapement to the West Branch of the St. Mary's River in 2005 was 198 fish (90% C.I. = 128, 434), of which 92% were small salmon (Table 7). When compared with historical data, this represents a substantial increase in the proportion of 1SW salmon in the spawning population (Amiro et al. 2000). Given that 55% of the river's juvenile habitat is contained within the West Branch, total escapement to the St. Mary's River in 2005 was estimated to be approximately 359 fish (90% CI = 233, 789), 331 small and 28 large salmon. As compared with 2004, this estimate represents a reduction in escapement of more than one-half for small salmon and approximately one-third for large salmon (Table 7).

Smolt abundance estimates

The St. Mary's River Association ran a program to monitor the smolt migration in the West Branch of this river, using two smolt-wheels deployed side by side. The wheel on the east side of the river operated from May 4th – June 5th and the wheel on the west side operated from May 10th – June 5th. To estimate population size as well as the capture efficiency of the two smolt-wheels, all captured smolts were tagged and released back upriver.

In total, 757 smolts were captured, the majority of them in the west-side wheel (Figure 13). Of these, 78 fish were tagged, indicating that they had been captured a second time. From these data, the number of smolt emigrating from the West Branch was estimated to be 7,350 smolts (90% C.I. = 6,000, 9,000), and capture efficiency at the west and east wheels was approximately 8.5% and 1.8% respectively. Based on an estimated 3,985,400 m^2 of juvenile habitat contained in the entire St. Mary's River (55% in the West Branch), smolt production was 0.33 smolts per 100 m^2.

The biological characteristics of the sampled population were estimated from a subset of the total population (229 individuals). Of these, 81% (181 smolts) were age-2 and 19% (44 smolts) were age-3. Overall, mean fork length was 14.9 cm (range: 11 – 19). On average, age-2 smolts were approximately 2 cm smaller than age-3, with mean fork lengths of 14.5 cm and 16.3 cm respectively.

Juvenile abundance

Mean age class densities were calculated based on data from 12 sites in 2004 (Table 8), and 11 sites in 2005 (Table 9). In 2005, the estimates of fry (age-0) and total parr (age-1 and age-2 combined) density are slightly greater than in 2004. Fry density (age-0) is at its highest value since 2001, and parr densities (age-1 and age-2 respectively) are the highest values recorded within the last three years (Figure 14). Nonetheless, the densities are still low relative to values in the mid 1990's. Any recent juvenile population

increase must be interpreted with caution. Given that adults return to spawn roughly four years after their parents, the adults in 2005 would have been fry in 2001. Mean fry densities in 2005 remain below mean densities in 2001.

The mean fry density observed in 2005 is consistent with the predicted linear relationship between estimated salmon returns and subsequent fry density for the years 1993-2005 (Figure 15). The similarity between the predicted and observed relationship for 2005 suggests that escapement in 2004 (884 fish) was accurately estimated. In contrast, it is likely that actual escapement in 2003 was significantly less than the estimated value; given an observed fry density of 3.08 fish per 100 m^2 in 2004.

Conservation requirement

At present, salmon escapement relative to conservation requirements is only assessed for two rivers in the Southern Uplands region, the St. Mary's River in SFA 20 and the LaHave River in SFA 21. For the entire St. Mary's River, the conservation requirement is 7.4 million eggs, which is equivalent to about 3,155 adult salmon. This requirement is partially based on the estimated number of habitat units (100 m^2) suitable for juvenile production contained in the St. Mary's River (39,854 units) (O'Connell et al. 1997).

Total escapement (359 fish) in 2005 was approximately 11% of the conservation requirement, which is the lowest value recorded within the last 10 years (Table 7). These data indicate that adult escapement (and subsequent egg deposition) in the St. Mary's River continues to be substantially less than pre-1997 values. Similarly, smolt production (estimated at 0.33 per habitat unit) is substantially less than the number produced by healthy Atlantic salmon populations in good habitat (> 3 per habitat unit).

Outlook

In combination, the low escapement estimates, increase in first-time spawners in the past eight years, low smolt production, and low juvenile densities in the previous three years indicate that the Atlantic salmon population in the St. Mary's River is unstable and in decline. Estimated returns in 2005 are at their lowest point in 11 years. Compounding these issues is the diminishing age-at-maturity of adults brought about by an increase in the proportion of age-2 smolts. Mean time to recruitment is now closer to four years than five, which decreases the degree of overlap among age classes. If marine survival remains unchanged and adult returns do not substantially increase in 2006, then actions to mitigate population decline and to protect genetic diversity may need to be considered.

Other rivers

Historically in SFA 20, annual stocking of smolts as well as electrofishing surveys to monitor juvenile density have taken place on the Musquoidoboit River. Similarly, electrofishing surveys were carried out on the Ecum Secum River in 1999, and adult returns to the Liscomb River fishway were monitored from 1983-1999 (Amiro et al. 2000). These monitoring programs have not continued to the present time.

In an effort to re-establish viable Atlantic salmon populations in SFA 20, a supportive rearing program has been in place since 2003. Small numbers of fry and parr have been removed from 6 low-acidified rivers in SFA 20 for the last two years (Table 10). These individuals are being raised to adulthood before being released in fresh water. Collections from each river were below those expected to produce a viable population, so it was necessary to pool all of the wild salmon for release into a single river. In SFA 20, the Quoddy River is considered to be the best non-origin release location for two reasons: (1) only a remnant wild population persists, and (2) the river contains suitable habitat (good pH, as well as an estimated 6,849 habitat units for juvenile production). In 2005, 69 adults (mostly from the 2003 juvenile collection) were released above 3rd lake on the Quoddy River.

Southwest Nova Scotia – SFA 21

LaHave River

Habitat

The LaHave River drains approximately 1,670 km^2 of the Southern Upland of Nova Scotia, and enters the ocean at Bridgewater, Lunenburg County. The drainage contains 113 lakes with a total surface area of 7,515 ha, and consists of five major sub-drainages: West Branch, North Branch, Ohio River, North River and the Main Stem (Figure 16) (Gray et al. 1989).

Throughout its length, the LaHave River contains several natural and manmade barriers to salmon migration. One of the larger obstacles is Morgan Falls, presently the site of a hydroelectric facility built in 1995. Morgan Falls is on the Main Stem of the LaHave River and is downstream of the Ohio and North River sub-drainages. Prior to the 1960's, Atlantic salmon had limited access the watershed upstream of Morgan Falls. In the late-1960's, a fishway was put in to bypass the falls and DFO began a stocking program to enhance the developing salmon run.

Biological Characteristics

Original broodstock were taken from the nearby Medway River, and the first hatchery-reared smolts were released above Morgan Falls in 1971 (Table 11). Since 1971 (excluding 1982), the LaHave River has been stocked annually with hatchery-reared smolts. After 1972, all broodstock were collected at the Morgan Falls fishway. The biological characteristics of the wild proportion of the population differ from those of the hatchery proportion. In general, the majority of wild juveniles undergo smoltification after two years in fresh water and approximately 80% mature after one winter at sea. About 40% of wild 1SW fish are female and about 90% of wild 2SW salmon are female (Amiro, unpublished data). In contrast, approximately 60% of juveniles of hatchery origin undergo smoltification after one year in fresh water. The proportion of adults of hatchery origin contributing to annual egg deposition has ranged from 94% to 11% and is presently declining (Amiro, unpublished data). Overall, 1SW salmon (wild and hatchery) contribute approximately 1, 240 eggs per fish annually, while 2SW salmon contribute an average of 5,120 eggs per fish. Despite differences in escapement among large and small salmon, each size class contributes approximately 50% of the total annual egg deposition above Morgan Falls.

Recreational fishery

Nine rivers in SFA 21 were open to angling within a season from June 1st to July 15th, 2005. More than 80% of the total fishing effort occurred on the LaHave River, which led to more than 90% (226 fish) of the total recreational catch (Table 1). Anglers spent an estimated 599 rod-days on the LaHave River in 2005, nearly double the 325 rod-days spent in 2004 and the previous 5-year mean (315 rod-days). Catches in 2005 were above those in 2004, at 165 small and 61 large salmon (as compared to 121 small and 34 large in 2004). Similarly, the catch in 2005 was 46% higher than the previous 5-year mean for small salmon, and 22% higher for large (Table 1).

Adult Status

Upstream-migrating adult salmon have been counted at the Morgan Falls fishway since 1972, and downstream migrating smolts have been counted each May since 1996 (last reported by Amiro et al. 2000). Scale samples are taked from all wild fish in the fishway and every 5th hatchery fish. In 2005, 500 adult salmon (416 small and 84 large) were counted, of which, 233 small and 43 large were of wild origin. The total number of wild salmon (276 fish) was the lowest recorded value since 2001 (Figure 17, Table 12). Recent wild returns are similar to those recorded before the fishway enabled efficient passage upstream of Morgan Falls.

Very few Atlantic salmon were removed for broodstock in 2005, and all were of hatchery origin (Table 12). The DFO smolt enhancement program on the LaHave River was discontinued in 2003, so no broodstock

were removed for stocking purposes in 2004 or 2005. The 9 individuals removed in 2005 were for use in the educational program 'Fish Friends' run by the Nova Scotia Salmon Association.

The biological characteristics the adults sampled at Morgan Falls in 2005 are summarized in Table 13. The majority of individuals (wild and hatchery) spent 2 years in fresh water and one winter at sea before returning to spawn. Combining the various ages, first-time spawners made up approximately 96% of the sampled population, second-time spawners less than 3%, and third-time spawners the remainder (< 2%). For both size categories, wild salmon were proportionally more abundant than hatchery salmon, with 60% 1SW and 12% MSW wild (72% total) as compared to 18% 1SW and 10% MSW of hatchery origin (28% total) (Figure 17, Table 11).

Smolt abundance estimates

The LaHave River above Morgan Falls remains the most heavily stocked river within the Southern Uplands region, receiving 32,219 smolts in 2004 and 1,880 smolts in 2005 (Appendix 2). Only two other rivers in SFA 21 were stocked with smolts in 2005, the Tusket River (1,880 smolts) and the Medway River (300 smolts). All smolts of hatchery origin are tagged or adipose-clipped before being released into the rivers.

Outward-migrating smolts are counted annually at the Morgan Falls fishway and mark-recapture methods are used to obtain an estimate of catch rate as well as of population size. In 2005, counts took place on weekdays from May 3rd – June 8th, although no smolts were found in the fishway after June 2nd. A total of 1430 marked smolts (700 T-bar tagged and 530 adipose clipped) of hatchery origin were released upstream of Morgan Falls during May, 2005.

The Bayesian estimate of smolt population abundance for the LaHave River above Morgan Falls was 6,690 fish (90% C.I. = 6120, 7400). Of the 1,430 marked individuals, 238 were recaptured, giving an estimated mean catch rate of 0.67 for 2005. After accounting for smolts of hatchery origin, wild smolt production in 2005 was estimated to be 5260 fish (90% C.I. = 4690, 5970). This is significantly lower than any value recorded during the years 1996 – 2004 (Figure 18, Table 14). Smolt production in 2005 was nearly 4 times lower than in 2004, and was over 3 times lower than the previous 5-year mean. Irregular flow patterns were experienced in the LaHave River in 2005, so it is possible that this estimate is low relative to actual smolt production. The return rate of 1SW adults in 2006 will give some indication if smolt production was underestimated in 2005.

Based on a subset of 158 wild smolts, approximately 70% (110 fish) of the sampled population were age-2 and 30% (48 fish) were age-3. On average, mean fork length of age-2 smolts was approximately 2 cm smaller than for age-3, at 16.37 cm (range: 13.5 – 19.7) and 18.80 cm (range: 15.8 – 23.5) respectively.

Because 96% of the adult population returns to spawn after one winter at sea, the ratio between smolt production and subsequent 1SW returns provides an estimate of the return rate of smolts (indicative of at-sea survival). For the LaHave River above Morgan Falls, return rates have ranged from 1.1% to 4.8%, with half of the values being > 2% (Table 14). Return rates have been declining steadily since 2001, with the lowest estimate being recorded in 2004. Smolt production in the corresponding years has been high, so the decline in return rates is likely due to low marine survival during this time period. Wild fish appear to be more susceptible to changes in marine conditions than hatchery fish given that return rates are much more variable over time (Figure 19)

The return rate of hatchery smolts as 1SW fish has been consistently lower than that of wild fish. In 2005, it decreased to 0.57% from 0.72% in the previous year, and is below the 5-year mean value of 0.64% (Figure 19). This discrepancy could be related to broodstock selection. Since 1996, broodstock selection was proportional to the wild and hatchery components of the migrating population, which necessitated using some fish of hatchery origin (approaching 50% in later years). The selection of adult broodstock for enhancement ceased at Morgans Falls in 2003, so it is expected that the proportion of salmon of hatchery origin within the population will quickly decline, beginning in 2006.

Juvenile abundance

A total of 16 electrofishing sites, 9 located above Morgan Falls and 7 located below, were surveyed on the LaHave River in 2004 and 2005 respectively (Table 15, Table 16). In 2005, all juvenile salmon captured were marked during the initial electrofishing pass at each site, and 13 out of the 16 sites were revisited 1-2 days later for the recapture pass (Table 16). The density of each age class (age-0, age-1 and age-2) at each two-pass site was calculated using a Peterson estimate (Gibson et al. 2003a, Gibson & Amiro 2003), and density at each single-pass site was estimated based on total catch multiplied by a site-specific estimate of efficiency for an electrofishing pass.

Mean parr density (age-1 and age-2 combined) for the LaHave River in 2005 was 11.5 fish/100 m^2 above Morgan Falls (7 sites), and 6.5 fish/100 m^2 below (9 sites) (Figure 20). The overall mean of 8.5 fish/100 m^2 in 2005 is similar to the long-term (1972 - 2004) mean density of 7.3 fish/100 m^2. Despite relatively large changes in escapement at Morgan Falls over time (refer back to Figure 17) mean parr density throughout the LaHave River has remained relatively unchanged (Figure 21). If juvenile productivity begins to decline concurrently with adult returns, future supportive rearing programs may need to be designed to lessen the genetic impact on the population relative to historic smolt stocking. An alternative population maintenance technique would be to collect juvenile salmon from the LaHave River, rear them to adulthood, and re-release them as adults to spawn naturally.

Conservation requirement

The conservation requirement for egg deposition above Morgan Falls on the LaHave River is set at 1.96 million eggs. Given the mean length of adult females sampled in 2005, mean fecundity of 1SW and MSW salmon were estimated to be 1,564 eggs per fish and 3,111 eggs per fish respectively. Therefore, the estimated escapement of 416 small and 84 large salmon in 2005 indicated that 58% of the conservation requirement was attained. Approximately 46% of total egg deposition in 2005 came from salmon of hatchery-origin. An additional 202 escaped female salmon were required in order to meet conservation targets in 2005 (Table 17). In contrast, the conservation requirement was achieved in 2004, and escapement has been slightly below the conservation target throughout the previous 5-year period (Figure 22).

Outlook

Declining wild returns, low smolt-to-adult return rates, and low survival of hatchery smolts in 2005 demonstrated that the salmon population in the LaHave River above Morgan Falls was substantially below conservation requirements. Decreases in marine survival of wild smolts have occurred since 2001 (as indicated by the return rate of 1SW adults) and may have been exacerbated by domestication selection within the population as a result of the high proportion of adults of hatchery-origin. This was part of the reason that the smolt enhancement program was discontinued in 2003.

Other Rivers

Two fishways on the partially-acidified Tusket River (Yarmouth Co.) were not monitored for adult escapement in 2005 (escapement results were last reported by Amiro et al. 2000). However, enhancement activities have been ongoing since 1979, and a total of 1,800 hatchery smolts were released into the Tusket River in 2005. The heavily-acidified rivers of SFA 21 are thought to be unable to support viable salmon populations, although remnant populations may still persist in some rivers. Based on the 2000 electrofishing survey on rivers throughout SFA 21 (Amiro et al. 2000) and parr broodstock collections in 2003 and 2004, residual populations in partially-acidified and heavily-acidified rivers are critically low and their persistence is in jeopardy.

Conservation of populations – SFA 20 and 21

Supplementation through artificial breeding and rearing has been used to enhance Atlantic salmon populations for fisheries for over a century. After the acidification of rivers in the Southern Uplands, this

technique was widely applied and appeared to be numerically viable throughout the 1980's. However, recent assessments in SFA 21 have shown continued decline (relative to the 1980's) in both the wild and enhanced components of salmon populations. In the cases of the acidified Liscomb, Medway, East, and Tusket Rivers, population enhancement of smolts did not sustain adult escapement, presumably because of low marine survival coupled with high acidity in these rivers. At present, the population size of wild salmon is not large enough to conduct genetically safe fisheries enhancement programs in these rivers.

The method of fish culture used for conservation purposes underwent significant changes beginning in 1999, when fisheries enhancement programs (in which smolts were raised from wild broodstock and were released into the river) were scaled back. In recent years, live gene banks have been established in an effort to conserve remaining wild salmon populations. Within the Southern Upland, salmon are being collected from the wild as parr, are being raised in captivity to the adult life stages and are then being released back into the rivers. This approach bypasses the marine life stage in the wild, during which survival is very low, and will hopefully mitigate the effects of high marine mortality and aid in maintaining the genetic variability and fitness of the population. Although removing wild parr does affect the distribution of juveniles within the river system, adult survival will be greatly increased because individuals will not be exposed to deleterious conditions in the marine environment.

Outlook – SFA 20 and 21

Based on the status of the wild salmon stock above Morgans Falls on the LaHave River and the estimates of returns to the St. Mary's River, low-acidified rivers in SFA 20 and 21 are not expected to achieve conservation requirements in 2006. Supplementation of smolts does not appear to be sufficient to off-set low marine survival, and may be having deleterious effects on the wild component of these populations. Although stocking programs have been used on various rivers in an attempt to maintain recreational fisheries for adipose-clipped salmon, they do not seem to be a viable option for long-term conservation. Establishment of living gene banks for the remaining wild populations of the Southern Upland region has been initiated and needs to be assessed as a conservation measure.

Inner Bay of Fundy – parts of SFA 22 and 23

Monitoring activities were not undertaken in the Nova Scotian portion of the inner Bay of Fundy in 2005. Given the widespread and dramatic nature of the population declines that Gibson et al. (2006) documented throughout the region, conservation activities in 2005 were focused exclusively on maintaining the Live Gene Bank. Marine survival of inner Bay of Fundy salmon populations was found to be extremely low in 2003; rivers supported by the Live Gene Bank produced sufficient smolts to prevent extirpation but not to maintain viable populations. Based on monitoring programs in surrounding SFAs in 2005, there is no indication that marine survival of Atlantic salmon has increased in recent years.

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Table 1. Recreational catch and effort t for small (1SW) and large (MSW) Atlantic salmon on rivers open to angling throughout SFAs 19, 20 and 21. Values are estimated from license-stub returns for 2005 and 2004, and the 5-year mean (2000 – 2004) is presented for comparison.

	2005				2004				5-Year Mean (2000-2004)							
	Grilse (1SW)		Salmon (MSW)		Grilse (1SW)		Salmon (MSW)		Grilse (1SW)				Salmon (MSW)		Effort	
River	Retained	Released	Released	Effort	Retained	Released	Released	Effort	Retained	95% C.I.	Released	95% C.I.	Released	95% C.I.	Rod-Days	95% C.I.
SFA 19: EASTERN CAPE BRETON ISLAND																
ACONI BROOK	0	0	0	0	0	0	0	0	0.0	0.0	0.8	2.1	0.3	0.7	2.8	7.7
BADDECK	0	40	109	397	2	14	53	185	0.6	1.0	15.8	6.7	49.1	27.4	185.4	58.6
BARACHOIS	0	1	0	16	0	0	0	11	0.0	0.0	0.5	0.9	0.5	0.9	12.9	6.8
CATALONE	0	0	0	0	0	0	0	0	0.0	0.0	1.9	3.0	1.3	2.3	5.5	7.7
CLYBURNE	0	0	0	0	0	0	0	4	0.0	0.0	0.0	0.0	0.0	0.0	5.6	10.5
FRAMBOISE (GIANT LAKE)	0	0	0	1	0	0	0	0	0.0	0.0	2.5	4.4	0.0	0.0	10.6	17.1
FRENCHVALE BROOK	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GASPEREAUX	0	0	0	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	2.8
GERRATT	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND	0	20	0	13	0	7	2	35	0.0	0.0	15.0	14.4	1.2	1.6	54.4	39.6
GRANTMIRE BROOK	0	4	7	9	0	14	3	16	0.0	0.0	2.7	7.6	1.8	2.4	6.3	8.0
INDIAN BROOK	0	5	0	9	0	0	2	11	0.0	0.0	0.0	0.0	1.0	1.9	8.1	3.5
INGONISH	0	1	1	4	0	2	7	4	0.0	0.0	0.3	0.9	1.4	3.8	3.1	1.7
INHABITANTS	0	5	4	7	0	2	2	7	0.0	0.0	4.3	6.9	5.6	12.9	16.6	17.6
LITTLE LORRAINE	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LORRAINE BROOK	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MACASKILL'S BROOK	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MARIE JOSEPH	0	0	0	1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MIDDLE	0	38	133	458	0	22	44	185	0.3	0.7	20.4	7.7	59.9	58.4	231.0	122.0
MIRA	0	1	0	43	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	4.1
NORTH ASPY	0	7	21	63	0	0	22	29	0.0	0.0	0.0	0.0	7.5	11.7	20.7	23.4
NORTH	1	54	171	441	0	70	152	505	0.0	0.0	50.8	28.5	88.2	76.2	364.9	170.5
NORTHWEST BROOK (RIVER	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER BENNETT	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER DENY'S	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RIVER TILLARD	0	0	0	0	0	0	0	2	0.0	0.0	0.0	0.0	0.3	0.8	3.4	5.0
SAINT ESPRIT	0	0	0	0	0	0	0	0	0.0	0.0	0.3	0.7	0.3	0.7	0.3	0.7
SALMON: CAPE BRETON CO.	0	0	0	38	0	0	2	5	0.0	0.0	3.1	4.3	3.1	5.0	11.0	8.3
SKYE	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYDNEY	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SFA TOTALS :	1	176	447	1501	2	130	289	1000	0.8	1.0	118.4	43.4	221.3	156.2	946.6	358.6

Table 1. continued.

	2005				2004				5-Year Mean (2000-2004)							
	Grilse (1SW)		Salmon (MSW)		Grilse (1SW)		Salmon (MSW)		Grilse (1SW)				Salmon (MSW)		Effort	
River	Retained	Released	Released	Effort	Retained	Released	Released	Effort	Retained	95% C.I.	Released	95% C.I.	Released	95% C.I.	Rod-Days	95% C.I.
SFA 20: EASTERN SHORE																
CLAM HARBOUR	River Closed				River Closed				0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A
EAST SHEET HARBOUR	0	0	0	0	0	0	0	5	0.0	0.0	0.0	0.0	0.3	0.8	3.3	2.8
ECUM SECUM	River Closed				River Closed				0.0	N/A	1.4	N/A	0.0	N/A	8.8	N/A
GUYSBOROUGH	0	1	0	1	River Closed											
LISCOMB	River Closed				River Closed				0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.3
MOSER	River Closed				0	2	0	2	0.0	N/A	0.9	N/A	0.0	N/A	1.6	N/A
MUSQUODOBOIT	0	1	4	25	0	15	2	38	0.3	0.7	10.9	12.7	1.7	1.4	45.5	48.4
NEW HARBOUR	River Closed				River Closed				0.0	N/A	4.4	N/A	0.0	N/A	2.9	N/A
SAINT MARY'S	0	13	0	119	0	39	21	105	0.0	0.0	57.5	80.6	36.2	84.8	181.1	173.9
SALMON RIVER	0	43	14	87	0	19	12	25	0.0	0.0	13.1	12.8	6.7	8.4	31.3	35.3
SFA TOTALS :	0	59	18	232	0	75	34	176	0.3	0.7	57.4	52.9	29.1	44.4	186.2	186.2
SFA 21: SOUTHWEST NOVA SCOTIA																
CLYDE	0	0	0	3	0	0	0	0	6.1	16.9	0.9	2.4	1.4	2.9	79.8	134.4
GOLD	0	0	0	1	River Closed				0.0	N/A	13.2	N/A	1.5	N/A	23.5	N/A
JORDAN	0	0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAHAVE	0	165	61	599	0	121	34	325	0.0	0.0	112.8	93.8	50.1	51.3	315.0	257.5
MEDWAY	0	1	0	1	River Closed											
MERSEY	1	3	4	62	17	0	5	444	8.5	8.2	1.6	3.6	1.8	2.7	196.6	178.7
MUSHAMUSH	0	1	0	5	0	0	0	0	0.0	0.0	0.4	1.2	0.0	0.0	0.4	1.2
SACKVILLE	0	3	0	30	0	0	0	31	0.0	0.0	2.0	5.0	1.4	3.1	33.5	25.8
TUSKET	0	0	0	12	0	5	3	62	0.0	0.0	4.9	6.7	1.7	2.4	55.1	35.0
SFA TOTALS :	1	173	65	713	17	127	43	862	14.6	20.4	123.7	101.1	56.0	51.4	667.3	246.6

Table 2. Summary of the angling catch and total removals of adult Atlantic salmon from Middle River during 1997 – 2005.

Year	Angling Catch		Angling Removals Mortality rate[1]		Angling Catch Retained	Unknown Removals		First Nations		Other		Total Removals	
	1SW	MSW	1SW	MSW	1SW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1997	18	80	1	4	3								
1998	31	60	1	3	5	5	9					11	12
1999	30	95	1	3	0	5	9					6	12
2000	20	67	1	2	0	8	37					9	39
2001	10	15	0	0	0	0	0					0	0
2002	29	37	1	1	1			1	5			3	6
2003	24	144	1	4	0							1	4
2004	23	39	1	1	0							1	1
2005	44	128	1	4	0							1	4

[1] Mortality rate: 0.05 for hook and release mortality for full season (June 1-Oct.31); 0.03 for shortened season (closed July 16-Aug. 31)

Table 3. Summary of the angling catch and total removals of adult Atlantic salmon from Baddeck River during 1994 – 2005.

Year	Angling Catch		Angling Removals Mortality rate[1]		Angling Catch Retained	Unknown Removals		First Nations		Other		Total Removals	
	1SW	MSW	1SW	MSW	1SW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1994	14	54	1	3	7							8	3
1995	53	62	3	3	7							10	3
1996	40	144	2	7	0							2	7
1997	14	64	1	3	0							1	3
1998	57	81	3	4	0	3	7					6	11
1999	15	79	0	2	1	3	7					4	9
2000	12	55	0	2	1	4	26					5	28
2001	11	20	0	1	0	0	0					0	1
2002	20	38	1	1	0	1	5					2	6
2003	24	77	1	2	0							1	2
2004	14	55	0	2	2							2	2
2005	48	131	1	4	0							1	4

[1] Hook and release mortality rate prior to 1998 was set at 5% but reduced to 3% in subsequent years.

Table 4. Summary of the angling catch and total removals of adult Atlantic salmon from North River during 1994 – 2005.

Year	Angling Catch		Angling Removals Mortality rate[1]		Angling Catch Retained	Unknown Removals		First Nations		Other		Total Removals	
	1SW	MSW	1SW	MSW	1SW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1994	65	84	3	4	0							3	4
1995	147	183	7	9	1							8	9
1996	151	108	8	5	0							8	5
1997	70	137	3	7	1							4	7
1998	108	104	3	3	0	0	0					3	3
1999	35	45	1	1	0	0	0					1	1
2000	32	27	1	1	0	0	0					1	1
2001	37	60	1	2	0	0	0					1	2
2002	34	46	1	1	0	4	16					5	17
2003	84	162	3	5	0							3	5
2004	71	157	2	5	0							2	5
2005	52	168	2	5	1							3	5

[1] Hook and release mortality rate prior to 1998 was set at 5% but reduced to 3% in 1998 and subsequent years.

Table 5. Summary of the angling catch and total removals of adult Atlantic salmon from above the fishway on Grand River during 1997 – 2005.

	Angling Catch		Angling Removals Mortality rate[1]		Angling Catch Retained	Unknown Removals		First Nations		Other		Total Removals	
Year	1SW	MSW	1SW	MSW	1SW	1SW	MSW	1SW	MSW	1SW	MSW	1SW	MSW
1997	31	6	2	0	3			0	0			5	0
1998	75	12	3	0	0	0	0	0	0	1		4	0
1999	17	3	1	0	0	9	0					10	0
2000	20	1	1	0	0							1	0
2001	1	0	0	0	0	0	0	0	0			0	0
2002	31	0	1	0	0	12	3					13	3
2003	17	3	1	0	0							1	0
2004	2	7	0	0	0							0	0
2005	15	0	1	0									0

[1] 4% hook and release mortality rate used (7% prior to 1998)

* 1SW mortality from the fishway in 1998

Table 6. Age, spawning history, and lengths of Atlantic salmon seined from the West branch of the St. Mary's River in 2005. The 'Age' designation gives the river- and sea-ages (r,s) of salmon, followed by the age after smolt of past spawning events (sp).

			Length (cm)					
	Number		Mean		Maximum		Minimum	
Age	Males	Females	Males	Females	Males	Females	Males	Females
2, 1	6	10	53.9	55.5	56.8	64.5	51.2	50.1
2, 2, sp 1		1				64.5		64.5
3, NA, sp 1		1				58.3		58.3
3, 1	4	4	54	54.1	57.6	56.5	48.8	53

Table 7. Estimated escapement of adult Atlantic salmon relative to the conservation requirement in the entire St. Mary's River for the years 1995 – 2005. Sampling takes place in the West branch of the river and is multiplied by 0.55 to scale up to the entire river.

Year	Grilse	Salmon	% Egg Conservation
1995	2038	437	78
1996	1535	590	67
1997	709	110	32
1998	1926	74	63
1999	559	150	22
2000	572	46	20
2001	580	193	24
2002	400	29	14
2003	1092	221	42
2004	843	41	28
2005	331	28	11

Table 8. Summary of the electrofishing sites surveyed on the St. Mary's River in 2004, including catch and estimated density for the three age classes of juvenile salmon.

Electrofishing Site	Area (m^2)	Age-0+ marks count	Age-1+				Age-2+				Density (per 100 m^2) Parr			Density (per 100 m^2) Fry	Coefficient of variation	
			M	C	R	Mort	M	C	R	Mort	age-1+	age-2+	total	age-0+	age-1+	age-2+
4.2	783	3	5	6	1		0	2	0		2.7	0.4	3.1	1.6	48.8	57.7
4.4	673	16	18	11	3		1	1	0		8.5	0.6	9.1	7.5	36.5	50.0
5.1	485	11	2	1	1		4	6	3		0.6	1.8	2.4	3.4	0.0	29.3
8.1**	380	0	0	No Recapture			0				0.0	0.0	0.0	0.0		
9.4**	3,104	3	7	No Recapture			2				0.6	0.2	0.7	0.2		
10.2**	703	0	0	No Recapture			0				0.0	0.0	0.0	0.0		
19.1+2	2,733	34	10	17	4		2	10	1		1.4	0.6	2.1	4.9	34.7	52.2
23.2	808	0	13	17	10		2	3	1		2.8	0.7	3.6	0.0	18.0	40.8
33**	2,709	12	4	No Recapture			0				0.4	0.0	0.4	1.1		
34**	4,389	12	5	No Recapture			4				0.3	0.2	0.5	0.7		
35**	521	34	5	4	0		0	1	0		2.4	0.0	2.4	16.0		
38**	1,363	8	0	No Recapture			0				0.0	0.0	0.0	1.4		
										Mean	**1.63**	**0.38**	**2.01**	**3.08**		

a. Counts at the mark run (M)
Total count at the capture run (C)
Numbers of recaptures in the capture run (R)
Numbers of mortalities (Mort)

** estimates obtained using mean age-1 efficiency

Table 9. Summary of the electrofishing sites surveyed on the St. Mary's River in 2005, including catch and estimated density for the three age classes of juvenile salmon.

Electrofishing Site	Area (m^2)	Age-0+ marks count	Age-1+				Age-2+				Density (per $100m^2$)				Coefficient of variation	
											Parr			Fry		
			M	C	R	Mort	M	C	R	Mort	age-1+	age-2+	total	age-0+	age-1+	age-2+
4.2	783	24	19	15	6		2	3	0		5.8	1.5	7.4	7.4	26.5	61.2
4.4	673	27	26	14	5		3	4	2		10.0	1.0	11.0	10.4	29.3	31.6
5.1	485	12	20	15	9		2	2	2		6.9	0.6	7.5	4.2	18.5	0.0
8.1	380	0	0	No recapture			0				0.0	0.0	0.0	0.0	0.0	0.0
9.4**	3,104	16	6	No recapture							****	****	****	1.4	0.0	0.0
10.8**	703	12	1	No recapture							****	****	****	4.7	0.0	0.0
19.1	714	46	16	15	3		3	4	2		9.5	0.9	10.5	27.4	38.7	31.6
23.2	808	58	1	3	1		9	8	5		0.5	1.9	2.4	28.7	40.8	21.8
33	2,709	41	2	6	2		8	6	3		0.3	0.6	0.8	5.3	37.8	29.3
34	4,389	70	24	7	3		3	0	0		1.1	0.1	1.2	3.3	31.6	0.0
35.1+2	287	50	24	17	10		7	5	5		14.3	2.8	17.1	29.7	18.0	0.0
										Mean	**5.39**	**1.04**	**6.43**	**11.14**		

a. Counts at the mark run (M)
Total count at the capture run (C)
Numbers of recaptures in the capture run (R)
Numbers of mortalities (Mort)

** estimates obtained using mean age-1 efficiency

Table 10. Location and numbers of juvenile Atlantic salmon removed from SFA 20 for the supportive rearing program in 2003 and 2004.

River	2003 fry	2003 parr	2004 fry	2004 parr
New Harbour	22	32	19	18
Indian Harbour	0	34	0	4
Ecum Secum	35	25	24	46
Gaspereaux	7	11	22	6
Salmon (Guysborough Co.)	43	2	2	6
Quoddy	0	3	0	0
Total	107	107	69	106

Table 11. Stock origins and the sea-age composition of adult Atlantic salmon returns to the Morgan Falls fishway on the LaHave River, 1970 – 2005.

	Hatchery		Wild		Totals		
Year	1SW	MSW	1SW	MSW	1SW	MSW	Combined
1970	--	--	2	4	2	4	6
1971	--	--	3	--	3	--	3
1972	9	--	8	2	17	2	19
1973	138	9	14	7	152	16	168
1974	442	19	29	2	471	21	492
1975	466	68	38	5	504	73	577
1976	468	108	178	23	646	131	777
1977	974	84	292	25	1266	109	1375
1978	567	209	275	67	842	276	1118
1979	1064	99	856	67	1920	166	2086
1980	336	489	1637	288	1973	777	2750
1981	1181	226	1866	366	3047	592	3639
1982	621	230	799	256	1420	486	1906
1983	27	100	1129	213	1156	313	1469
1984	250	36	2043	384	2293	420	2713
1985	102	77	1343	638	1445	715	2160
1986	135	78	1579	584	1724	662	2386
1987	573	79	2529	532	3102	611	3713
1988	1056	59	2464	390	3520	449	3969
1989	443	183	2087	511	2530	694	3224
1990	596	112	1880	396	2476	508	2984
1991	109	90	495	236	604	326	930
1992	574	58	1915	215	2489	273	2762
1993	381	84	777	121	1158	205	1363
1994	207	119	641	128	848	247	1095
1995	371	85	577	143	948	228	1176
1996	395	83	735	113	1130	196	1326
1997	146	65	303	66	449	131	580
1998	200	68	719	69	919	137	1056
1999	134	44	318	88	452	132	584
2000	293	53	501	67	794	120	914
2001	190	81	189	101	379	182	561
2002	711	33	422	38	1133	71	1204
2003	206	108	231	99	437	207	644
2004	326	56	312	66	638	122	760
2005	183	41	233	43	416	84	500

Table 12. Broodstock collected for smolt stocking programs in the LaHave River (1969 – 2005). Collections in 2005 were for educational purposes. M.F. stands for Morgan Falls fishway.

			1SW				MSW				
			Males		Females		Males		Females		
Year	River	Location	Hatch	Wild	Hatch	Wild	Hatch.	Wild	Hatch	Wild	Total
1969	Medway	Greenfield	0	48	0	26	0	8	0	28	110
1970	Medway	Greenfield	0	20	0	7	0	3	0	7	37
1971*	Medway	Greenfield	0	83	0	12	0	12	0	23	130
1972	Medway	Greenfield	0	37	0	19	0	10	0	22	88
1973	LaHave	M. F.	57	8	46	16	4	6	7	17	651
1974	LaHave	M. F.	21	0	24	4	9	1	12	0	71
1975	LaHave	M. F.	4	0	3	0	17	0	20	0	44
1976	LaHave	M. F.	2	0	0	0	13	4	32	8	59
1977	LaHave	M. F.	21	7	15	15	8	9	8	27	110
1978	LaHave	M. F.	18	6	6	3	19	6	25	11	94
1979	LaHave	M. F.	7	0	12	9	16	0	30	1	75
1980	LaHave	M. F.	0	5	0	0	12	3	12	2	34
1981	LaHave	M. F.	0	2	0	0	14	11	15	10	52
1982	LaHave	M. F.	0	2	0	0	4	7	10	6	29
1983	LaHave	M. F.	0	0	0	0	6	18	13	44	81
1984	LaHave	M. F.	0	0	0	0	0	43	5	59	107
1985	LaHave	M. F.	0	10	1	20	4	59	12	125	231
1986	LaHave	M. F.	0	0	0	0	6	27	10	112	155
1987	LaHave	M. F.	9	15	0	0	9	25	23	132	213
1988	LaHave	M. F.	14	39	0	3	8	8	24	109	205
1989	LaHave	M. F.	3	20	0	0	8	22	40	75	168
1990	LaHave	M. F.	5	27	2	5	13	9	28	74	163
1991	LaHave	M. F.	9	8	33	5	4	49	28	64	200
1992	LaHave	M. F.	21	31	4	46	5	12	17	59	195
1993	LaHave	M. F.	21	43	8	43	1	4	29	30	179
1994	LaHave	M. F.	8	14	0	24	9	3	33	23	114
1995	LaHave	M. F.	21	37	14	30	2	2	10	25	141
1996	LaHave	M. F.	19	22	2	12	6	1	16	17	95
1997	LaHave	M. F.	15	41	2	21	2	3	8	12	104
1998	LaHave	M. F.	15	69	5	43	0	2	16	7	157
1999	LaHave	M. F.	2	29	4	21	3	6	8	19	92
2000	LaHave	M. F.	3	38	6	6	3		12	12	80
2001	LaHave	M. F.	6	35		5		1	10	14	71
2002	LaHave	M. F.	6	16	4	14			6	6	52
2003	LaHave	M. F.	3	14		6		2	1	11	37
2004	LaHave	M. F.									
2005**	LaHave	M. F.	5		6						11

* LaHave broodstock collection consisted of 5 females and 22 males.

** Hatchery broodstock collected for Fish Friends

Table 13. Biological characteristics of the adult salmon returning upstream of Morgan Falls on the LaHave River in May to October of 2005. Age is shown as years spent in freshwater (fresh), years at sea (sea) and age (after smoltification) at previous spawning events (s1,s2). Salmon of hatchery and wild origin are considered separately. Samples were taken from all wild fish and every 5th hatchery fish present in the fishway when counts took place.

	Age						Fork length (cm)				Weight (kg)			
Origin	Fresh	Sea	s1	s2	s3	Number	Mean	Min.	Max.	Std. dev.	Mean	Min.	Max.	Std. dev.
Wild														
		1				3	53.4	52.5	54.2	0.7	1.9	19	19	0
	1	1				5	54.6	51.9	55.6	1.38	2.04	1.6	2.3	0.24
	2	1				153	53.9	47.8	59.8	1.96	1.95	1.4	2.4	0.2
	3	1				51	55	50.6	61.8	2.08	2.03	1.6	2.6	0.19
	1	2				2	74.15	70.5	77.8	3.65	5	4.2	5.8	0.8
	2	2				24	71.7	67.6	74.8	1.92	4.75	3.7	6	0.56
	3	2				5	71.5	67.5	74.7	3.05	4.7	3.4	5.4	0.81
	2	2	1			3	60.9	58.8	64.1	2.27	2.53	2.4	2.6	0.09
	3	2	1			1	59.3	59.3	59.3	0	2.4	2.4	2.4	0
	2	3	1			4	75.6	74	77.5	1.28	5.75	5.2	6.2	0.42
	3	3	1			1	72.6	72.6	72.6	0	5.3	5.3	5.3	0
	2	4	2			3	87.8	84	92.5	3.52	9.97	9.2	10.5	0.56
Hatchery														
	1	1				64	55.7	49.9	60.5	2.54	2.02	1.5	2.7	0.25
	3	1				1	57.3	57.3	57.3	0	2.5	2.5	2.5	0
		2				2	73.3	70	76.6	3.3	5.3	5	5.6	0.3
	1	2				29	72.7	68.7	78.5	2.49	4.93	3.4	6.4	0.69
	1	3	1			3	78.2	76.5	80	1.43	6.5	5.8	7.1	0.54
	1	4	2			3	83.4	82	85	1.23	9.07	8.2	9.5	0.61

Table 14. The estimated production (90% C.I.), density and return rate of wild smolts above Morgan Falls on the LaHave River during 1996 – 2005. The 'Return rate to 1SW' is a measure of the proportion of smolts that mature after one winter at sea and return to Morgan Falls in the following year.

	Wild smolts		Return
Smolt year	Estimate	Number per 100 m²	Rate to 1SW
1996	20510 (19890 – 21090)	0.4	1.47%
1997	16550 (16000 – 17100)	0.32	4.33%
1998	15600 (14700 – 16625)	0.31	2.04%
1999	10420 (9760 – 11060)	0.2	4.82%
2000	16300 (15950 – 16700)	0.32	1.16%
2001	15700 (15230 -16070)	0.31	2.70%
2002	11860 (11510 – 12210)	0.23	1.95%
2003	17,845 (8821 – 26,870)	0.13	1.75%
2004	21613 (19613 – 21513)	0.32	1.13%
2005	5,260 (4,693 – 5,974)	0.1	

Table 15. Juvenile Atlantic salmon captures at the electrofishing sites visited above and below Morgan Falls fishway on the LaHave River in 2004. Based on the mark-recapture data, fry and parr densities are estimated for each site.

			Total parr					Density (per 100 m^2)			
	Area	Age-0+					Proportion	Fry	Parr		Total
Electrofishing Site	m^2	count	M	C	R	Mort	Age 1	Age 0	Age 1	Age 2	parr
Falkland Ridge	1,081	4	0	0	0		0.67	1.51	2.01	1.01	3.02
Cherryfield Bridge	1,061	139	40	29	9		0.96	53.42	11.07	0.52	11.59
Veinot's Campground	1051	270	42	32	9		0.98	104.75	13.29	0.22	13.51
Pinehurst-upper site	1,728	6	0	0	0		1.00	1.42	0.24	0.00	0.24
Pinehurst-lower site	1,806	6	0	0	0		0.86	1.35	0.19	0.03	0.23
Wentzell Rd.	752	3	10	2	0		0.85	1.63	4.59	0.83	5.42
Fire Bk. West Br.	774	41	25	32	5		0.91	21.60	18.81	1.86	20.67
Fire Bk. West Br. (hatch)	774		1	0	0			0.00	0.51	0.00	0.51
Frauzel Rd. West Br.	768	53	14	13	1		1.00	28.14	7.43	0.00	7.43
Holland's Cabin	605	20	0	0	0		1.00	13.48	2.02	0.00	2.02
Mackays Bridge	1,051	1	0	0	0		1.00	0.39	3.88	0.00	3.88
Sherbrooke River N.B.	1018	12	21	37	5		0.97	4.81	13.27	0.41	13.68
West River	753	3	14	4	2		0.71	1.62	5.35	2.23	7.58
North River Cabin	607	11	17	32	5		0.93	7.39	15.14	1.16	16.30
West River (Conrads)	1290	23	13	18	4		0.86	7.27	3.57	0.56	4.13
West River	900	37	4	3	0		0.90	16.76	1.64	0.18	1.81
Meisners Section	1456	75	20	23	2		0.98	21.00	5.48	0.12	5.60
							Mean	**17.91**	**6.75**	**0.57**	**7.32**

Notes:

1. Parr densities calculated using mark recapture for all parr combined and then split using the proportion age-1
2. No parr older than age-2 captured
3. Single pass densities calculated using mean q
4. Fry densities calculated using the mean q
5. Zero recaps treated as single pass

Table 16. Juvenile Atlantic salmon captures at the electrofishing sites visited above and below Morgan Falls fishway on the LaHave River in 2005. Based on the mark-recapture data, fry and parr densities are estimated at each site.

		Age-0+	Capture data								Density (per 100 m^2)				Coefficient of variation	
	Area	marks	Age-1+				Age-2+				Parr			Fry		
Electrofishing Site	m^2	count	M	C	R	Mort	M	C	R	Mort	age-1+	age-2+	total	age-0+	age-1+	age-2+
Meisners Section	3,780	80	70	51	17		4	3	0		5.4	0.5	6.0	6.2	18.6	61.2
Falkland Ridge	1,240	3	24	24	6		3	0	0		7.2	0.3	7.5	0.9	30.0	0.0
Main Lahave River																
North River Cabin	1,093	39	34	22	8		10	8	4		8.2	1.8	10.0	9.4	24.7	27.2
Cherryfield Bridge	1,093	78	42	38	10		0	1	0		13.9	0.2	14.1	25.9	24.5	50.0
Veinot's Campgroun(	3,157	36	43	62	11		0	2	0		7.3	0.0	7.3	6.1	25.0	57.7
North Branch																
Pinehurst-upper site	8,632	1	4	No Recap			2				****	****	****	0.0	0.0	0.0
Pinehurst-lower site	4,450	1	4	No Recap			1				****	****	****	0.0	0.0	0.0
Wentzell Rd.	844	3	19	23	5		2	1	1		9.5	0.0	9.5	1.5	32.7	0.0
West Branch																
Fire Bk. West Br.	2101	31	51	53	12		12	13	4		10.3	1.7	12.0	6.2	23.3	32.7
Frauzel Rd. West Br.	1282	34	14	14	2		1	0	0		5.9	0.2	6.0	14.2	44.7	0.0
Holland's Cabin	1560	2	5	No Recap			1				****	****	****	0.0	0.0	0.0
North Branch																
Mackays Bridge	1278	6	15	10	1		0	1	0		6.9	0.2	7.0	2.8	52.2	50.0
North Branch																
Sherbrooke River N.I	1175	8	40	17	3		1	1	0		15.7	0.3	16.0	3.1	39.4	50.0
Above Texas Lake																
West River	300	0	11	7	4		1	1	0		6.4	1.3	7.7	0.0	25.0	50.0
Below Lake Pleasant																
West River (Conrads	1264	16	56	67	21						13.9	0.0	13.9	4.0	17.1	0.0
West River	778	17	46	45	12		1	1	1		21.4	0.3	21.6	7.9	22.6	0.0
										Mean	**10.2**	**0.5**	**10.7**	**5.5**		

a. Counts at the mark run (M)
Total count at the capture run (C)
Numbers of recaptures in the capture run (R)
Numbers of mortalities (Mort)

**** No estimate possible, density derived from total catch.

Table 17. Biological characteristics of the adult salmon sampled at Morgan Falls fishway in 2005, categorized by origin (wild and hatchery) as well as sea age. Based on the estimated fecundity of returning females, the conservation requirement of 1.96 million eggs for the LaHave River above Morgan Falls was not met in 2005.

Origin Post-smolt age	Gender	Number at age	Prop.	Broodstock removals	Angling+ Native harvest above	Mean length females (cm)	Mean fecundity (eggs)	Eggs contributed	Percent cont. to egg dep.	Required female spawners
Wild										
One-sea-winter	Female	123	0.25	5	0	53.8	3,128	369,372	32.8	205
	Male	110	0.22	0	0	54.7				
Multi-sea-winter	Female	39	0.08	0	0	72.8	6,223	242,683	21.5	68
	Male	4	0.01	0	0	67.0				
Hatchery				0						
One-sea-winter	Female	84	0.17	6	0	55.5	3,327	261,062	23.2	136
	Male	99	0.20	0	0	56.0				
Multi-sea-winter	Female	39	0.08	0	0	74.2	6,544	253,782	22.5	67
	Male	2	0.00	0	0	72.8				
Totals		500	1.00	(11)	(0)		4,805	1,126,899	100	
Escaped female spawners		285		-11	-0					=274
Required female spawners										=476
Surplus (Deficit) =										**(202)**

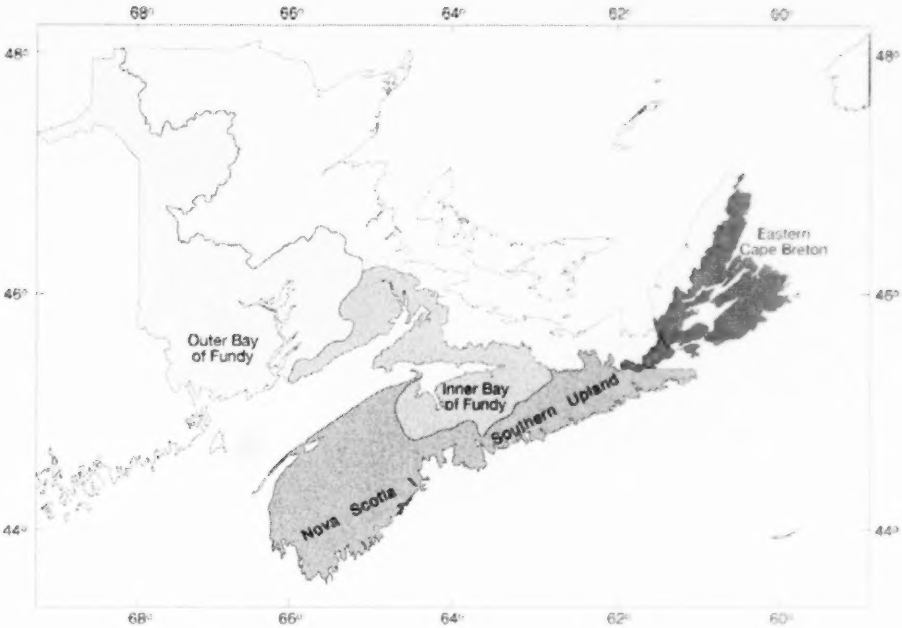

Figure 1. Location of the three regions assessed in this document: Eastern Cape Breton (SFA 19), the Southern Uplands (SFA 20 and 21), and the inner Bay of Fundy (parts of SFA 22 and 23)

Figure 2. Geographical location of the rivers in Eastern Cape Breton (SFA 19).

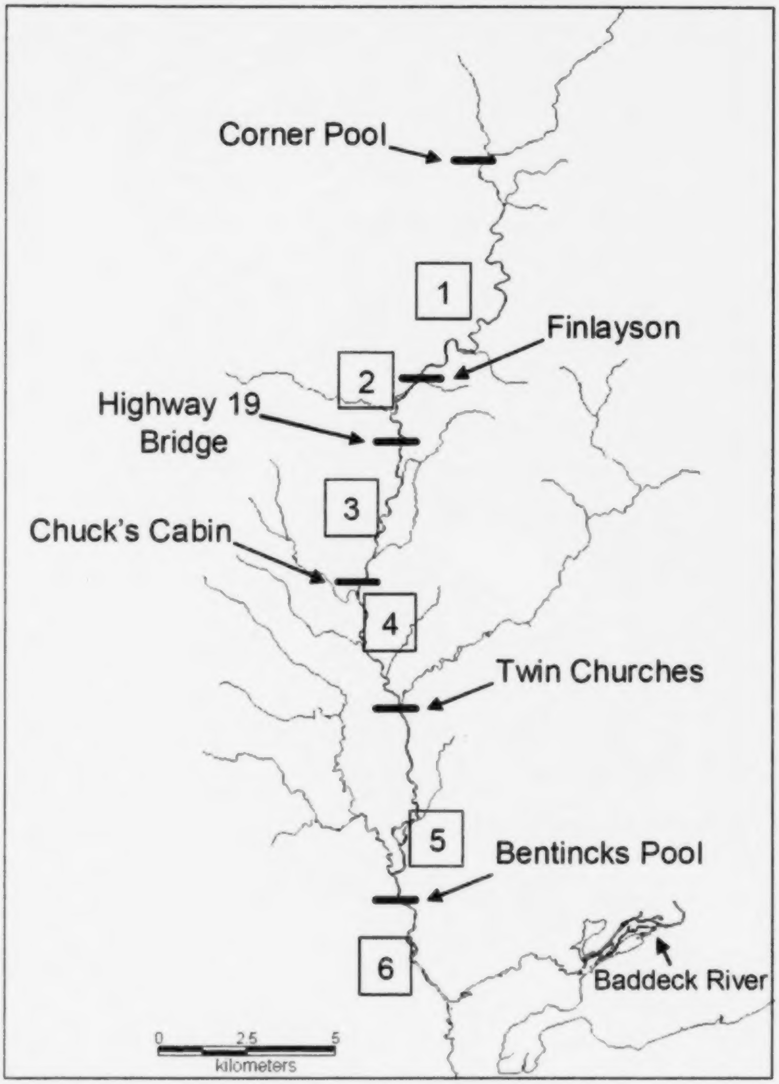

Figure 3. Map of the Middle River showing the locations of sections surveyed by divers (numbered, with the boundaries denoted by horizontal slashes), as well as the major landmarks.

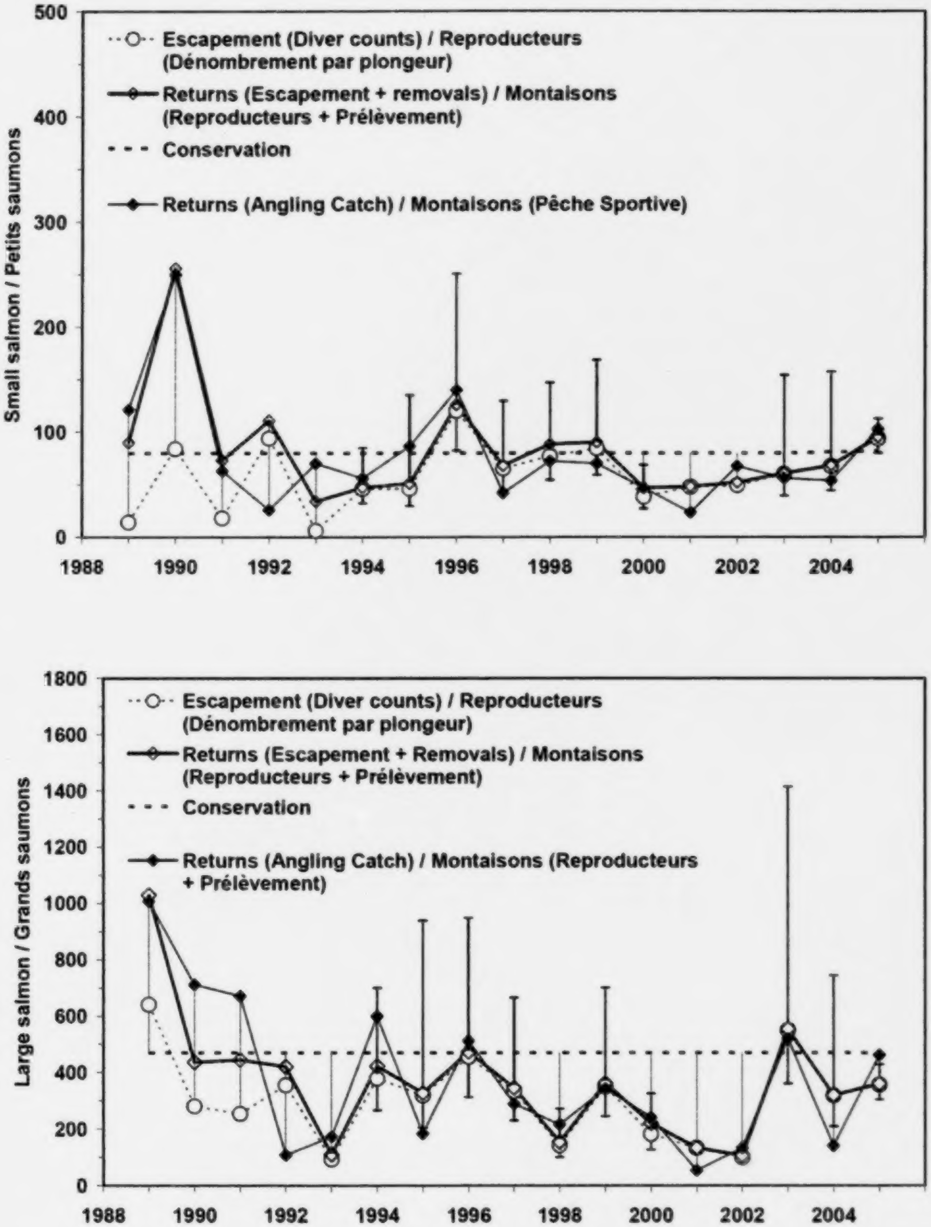

Figure 4. Adult returns (small salmon – top panel; large salmon – bottom panel) and escapement (plus 90% CI) relative to the conservation requirement for Middle River (1989-2005). Returns and escapement were higher in 2005 than in 2004, but only small salmon exceeded the conservation requirement (dashed line).

Figure 5. Map of the Baddeck River showing the locations of sections surveyed by divers (numbered, with the boundaries denoted by horizontal slashes), as well as the major landmarks and historical electrofishing sites (asterisks).

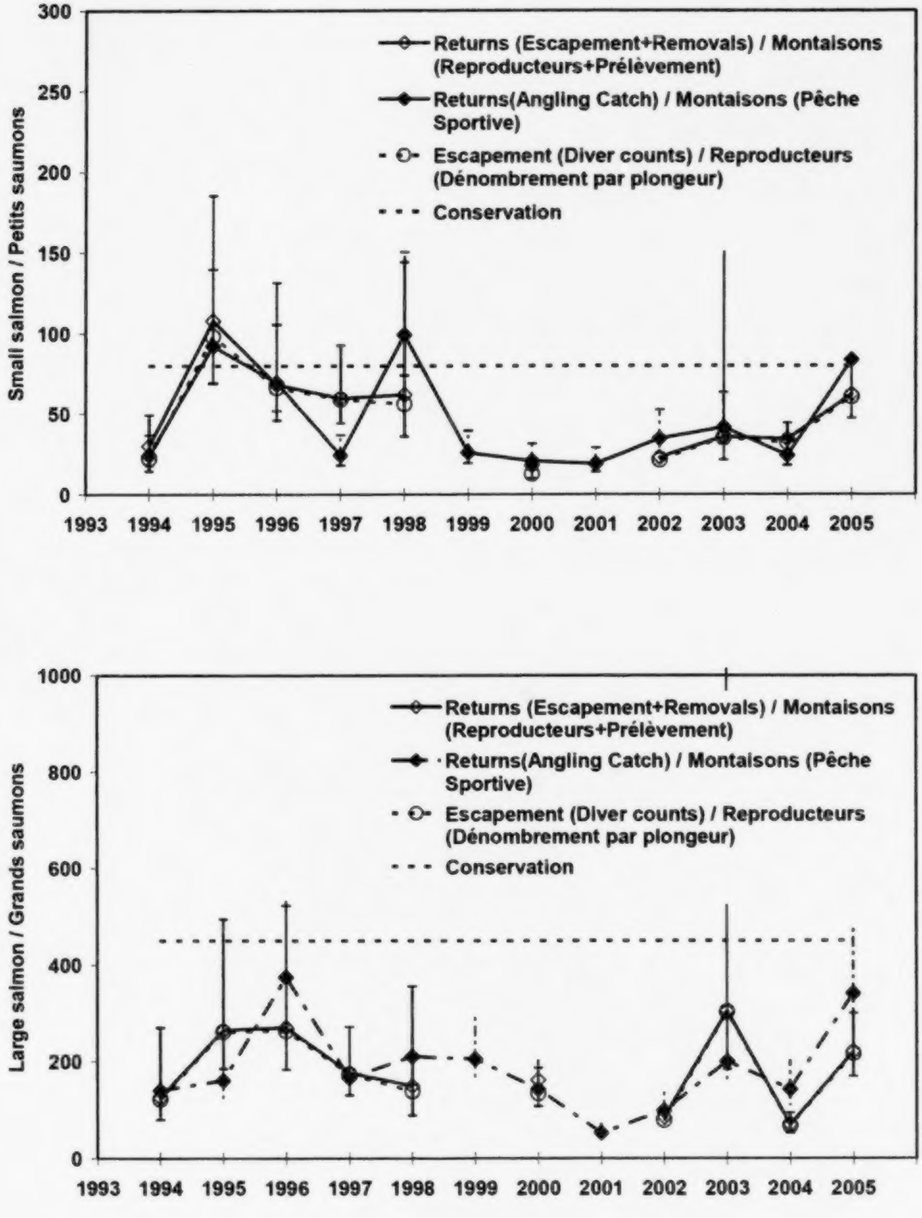

Figure 6. Adult returns (small salmon – top panel; large salmon – bottom panel) and escapement relative to the conservation requirement for Baddeck River (1994-2005). Returns and escapement were higher in 2005 than in 2004, but did not exceed the conservation requirement (dashed line).

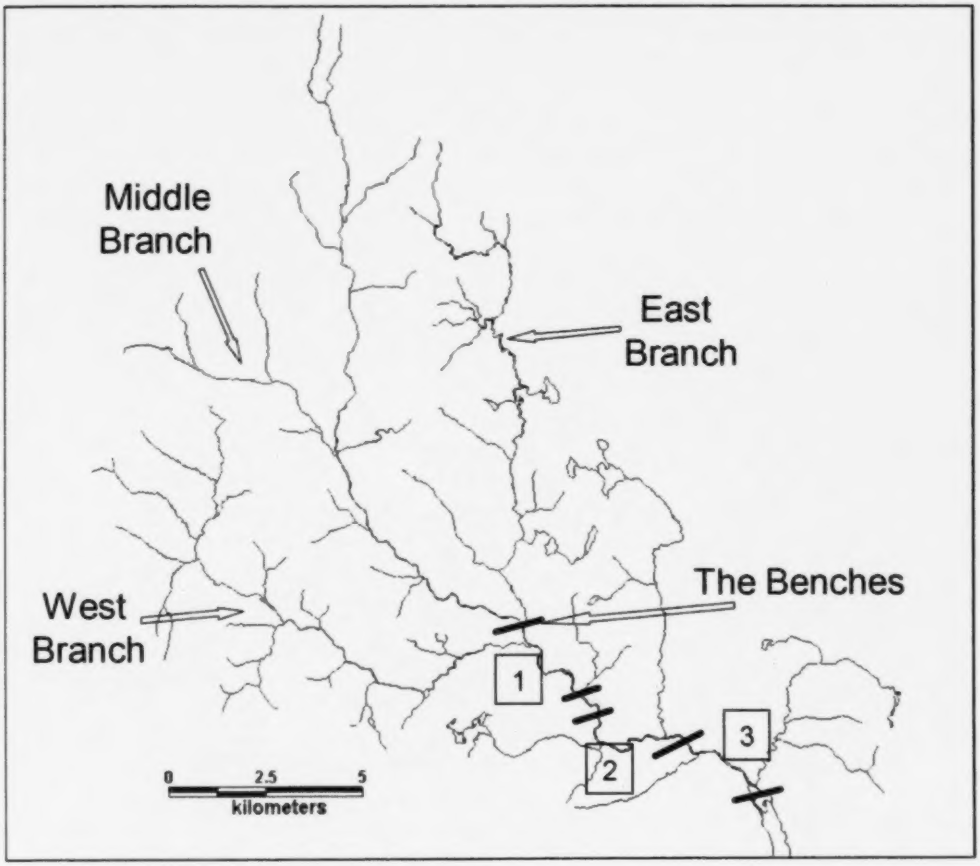

Figure 7. Map of the North River showing the locations of sections surveyed by divers (numbered, with the boundaries denoted by slashes), as well as the three major branches and 'the Benches' recreational fishing boundary.

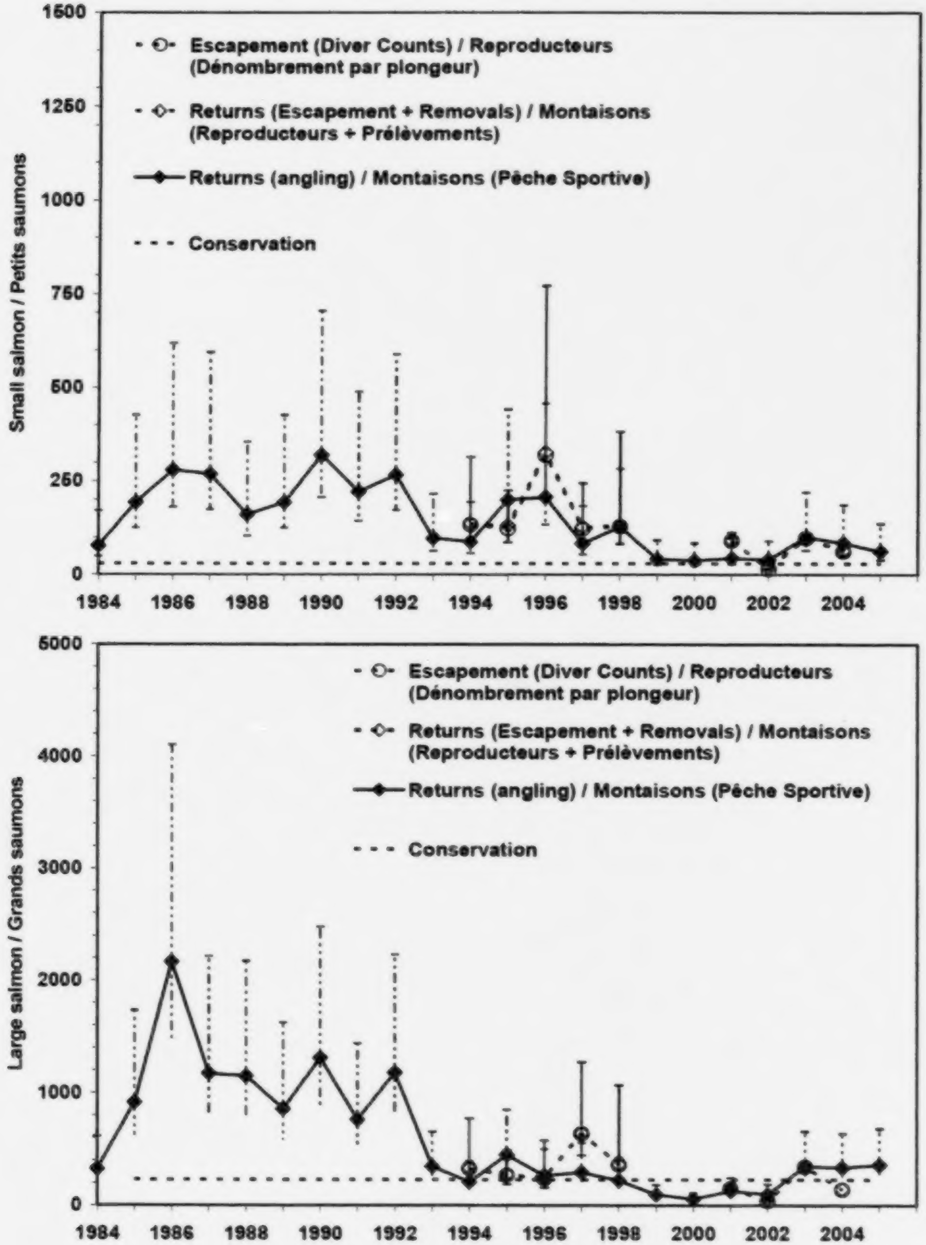

Figure 8. Adult returns (small salmon – top panel; large salmon – bottom panel) and escapement relative to the conservation requirement for North River (1984-2005). Recent estimates are based exclusively on recreational catch and the river-specific catch rate for small and large salmon. Returns and escapement were higher in 2005 than in 2004, and remain above the conservation requirement (dashed line).

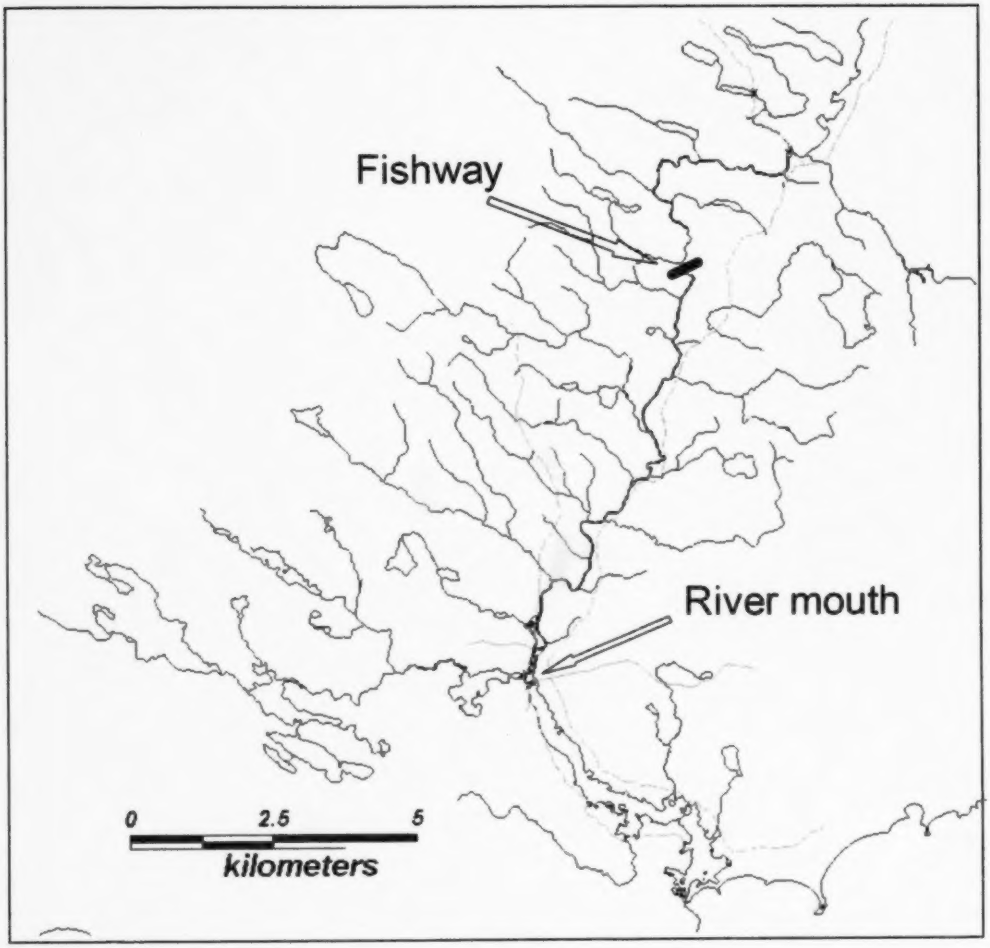

Figure 9. Map of the Grand River showing the location of the fishway at Grand River Falls.

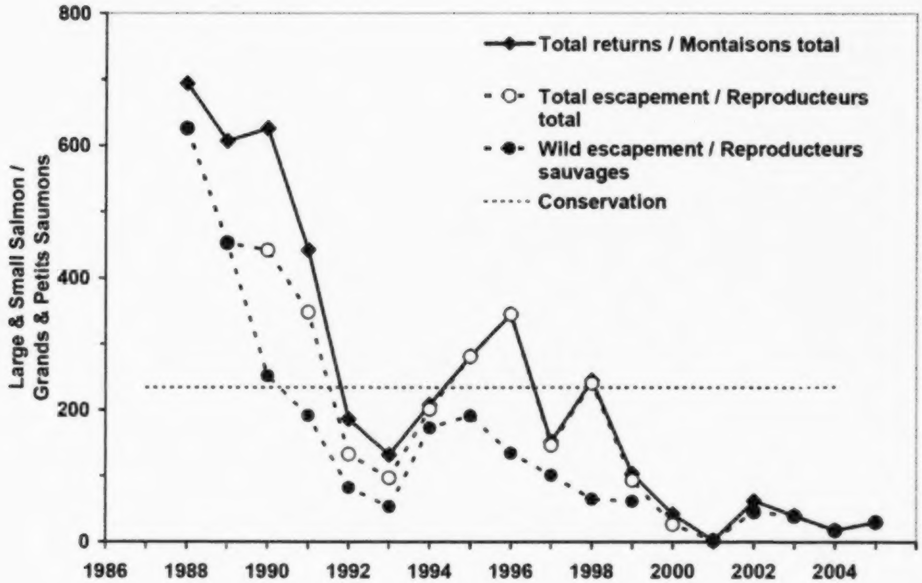

Figure 10. Total adult returns (large and small) and escapement relative to the conservation requirement for Grand River (1984-2005). Recent estimates are based exclusively on recreational catch, assuming a catch rate of 0.5. Returns and escapement were significantly lower than the conservation requirement (dashed line) in 2005, although numbers were higher than in 2004.

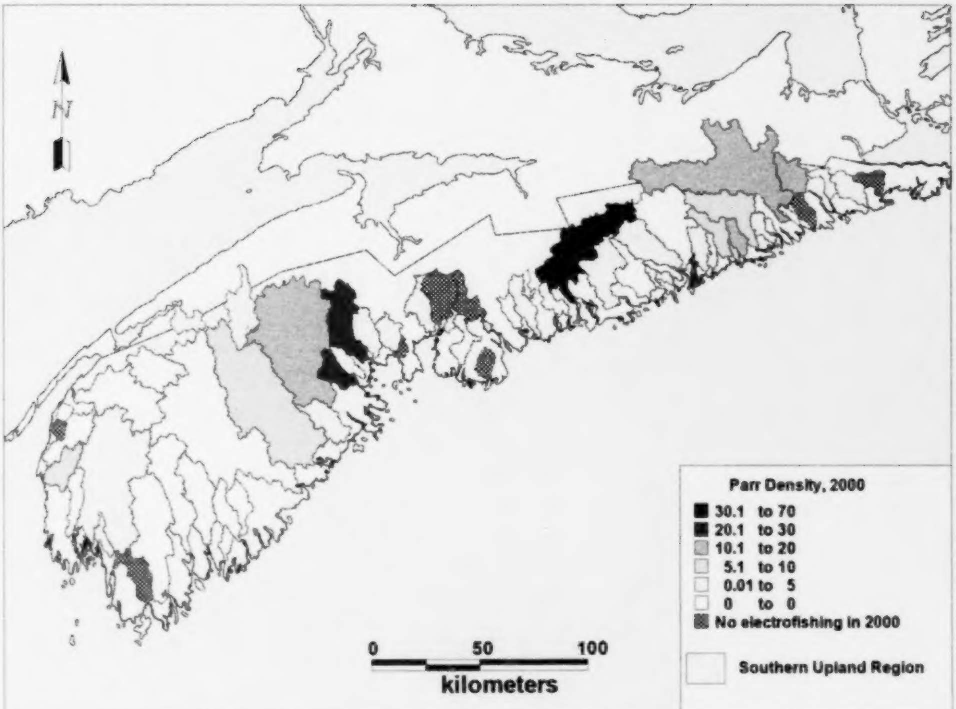

Figure 11. Map of the river drainage areas in the Southern Upland region of Nova Scotia and their associated total juvenile Atlantic salmon density (number per100 m^2), as determined by electrofishing in 2000.

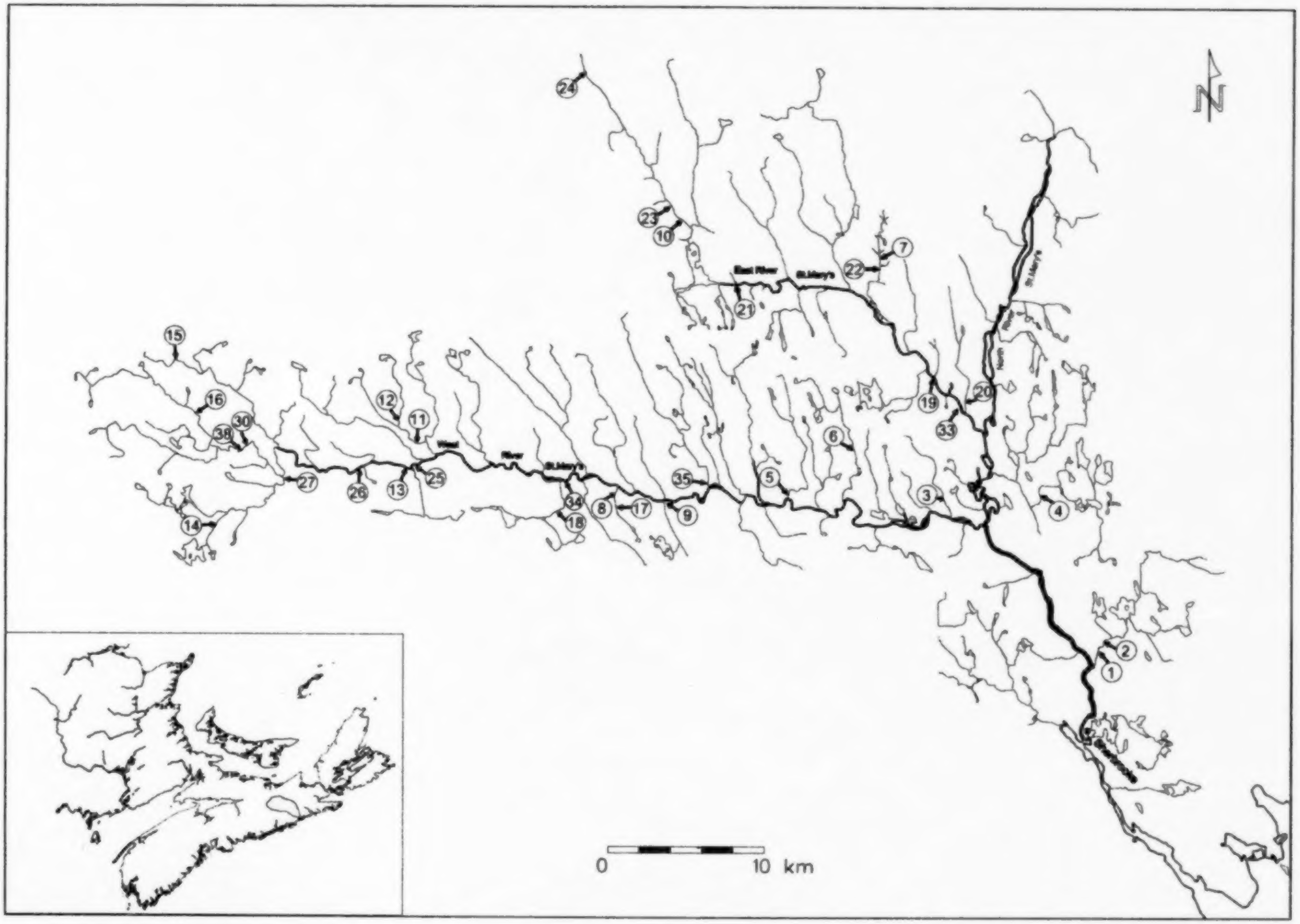

Figure 12. Map of the St. Mary's River in SFA 20, showing its location within Nova Scotia (bottom panel) as well as the locations of all electrofishing sites (numbers) throughout the river.

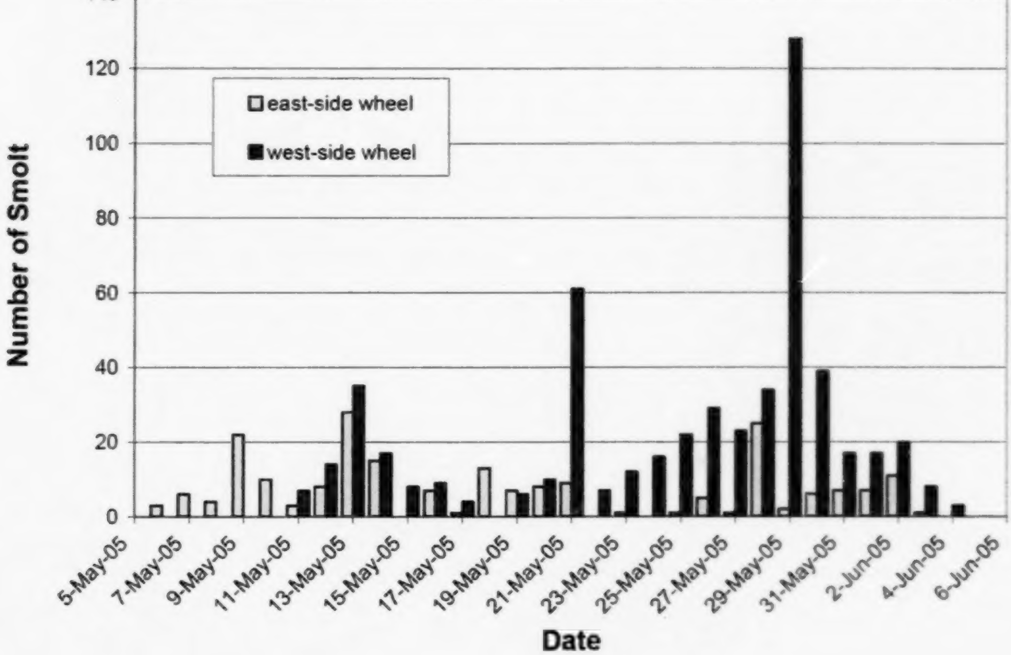

Figure 13. The number of smolts exiting the West branch of the St. Mary's River in the spring of 2005. Estimates are derived from a counting wheel placed on the east (light grey bars) or the west (dark grey bars) side of the river.

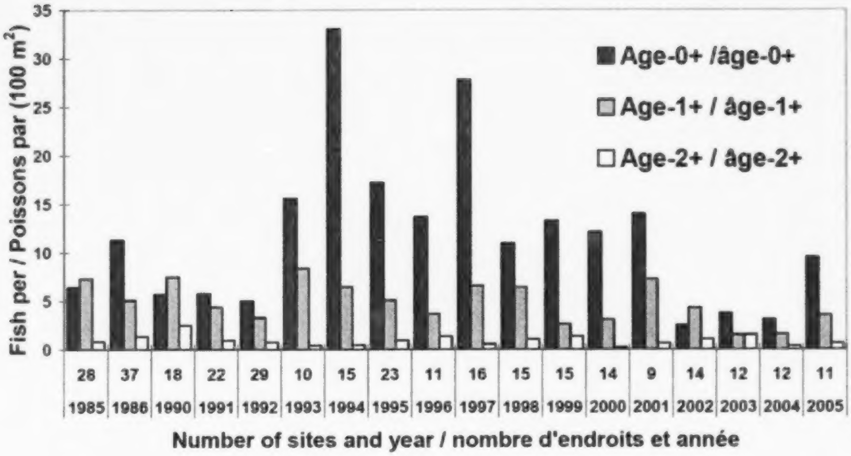

Figure 14. Mean density for the three age classes of juvenile salmon (age-0, age-1 and age-2) during 1985 – 1986, and 1990 – 2005. The number of sampling sites that the mean is based on is listed immediately below the x-axis.

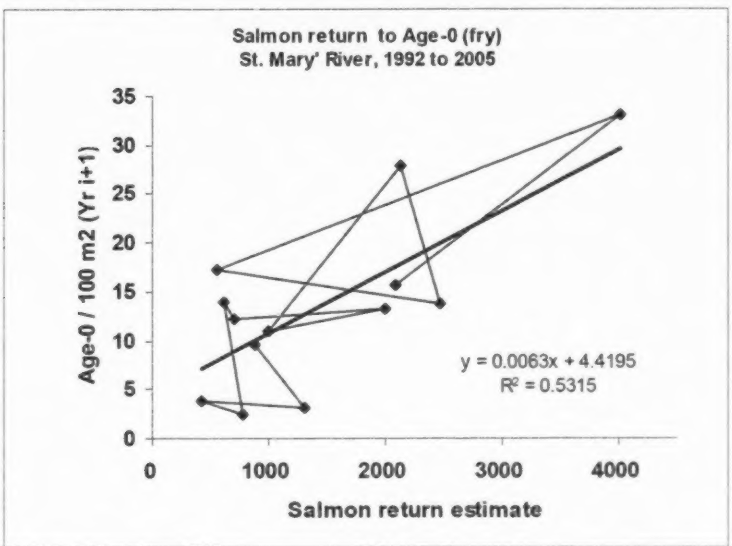

Figure 15. Observed fry density as a function of estimated adult returns to the St. Mary's River for the years 1993 – 2005. The linear equation for the predicted relationship (thick line) as well as the associated R^2 value for the regression is given. Points in the lower left corner are the most recent.

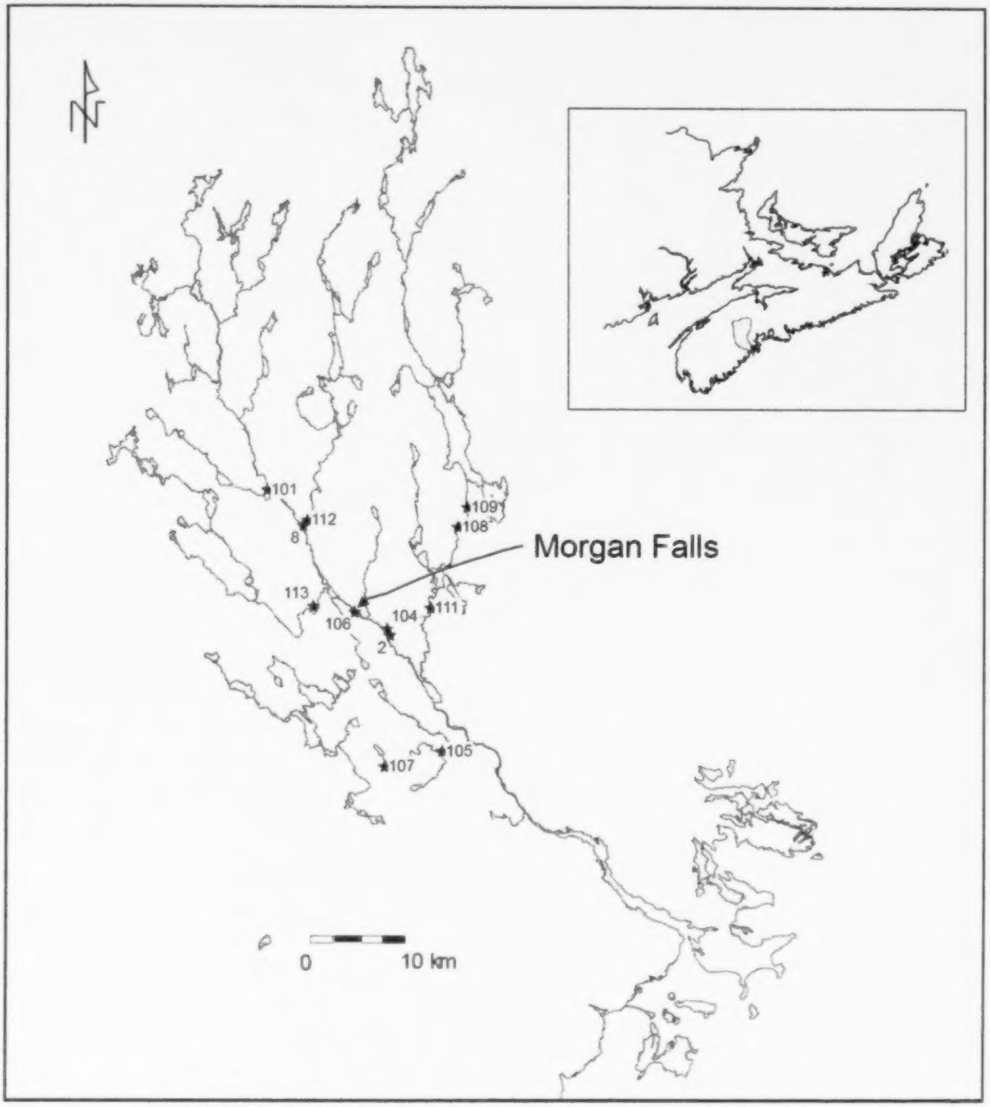

Figure 16. Map of the LaHave River watershed in SFA 21, showing its position within Nova Scotia (corner panel), the location of numbered electrofishing sites (stars) and the location of Morgan Falls (arrow).

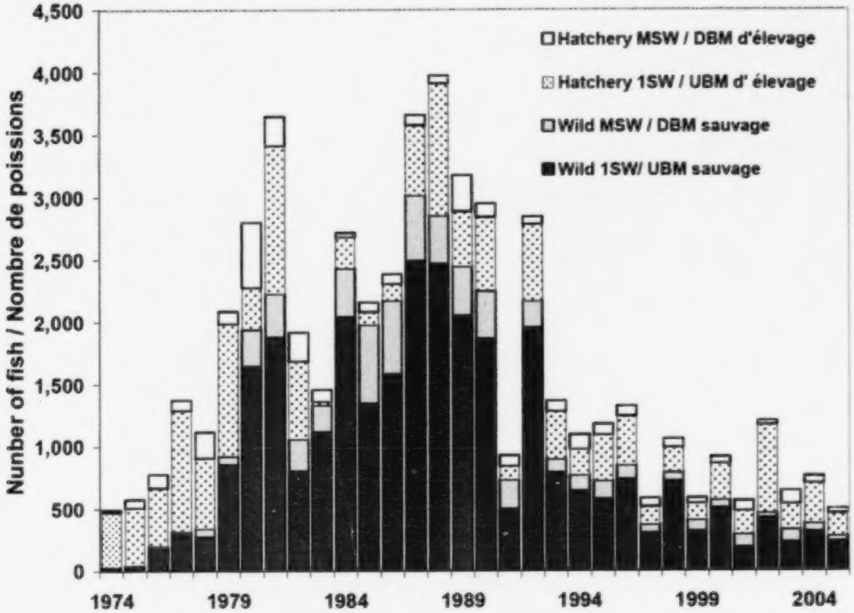

Figure 17. Annual returns of salmon to the LaHave River above Morgan Falls during 1974 – 2005 broken into the proportions of small (1SW) and large (MSW) as well as hatchery and wild in the sampled population.

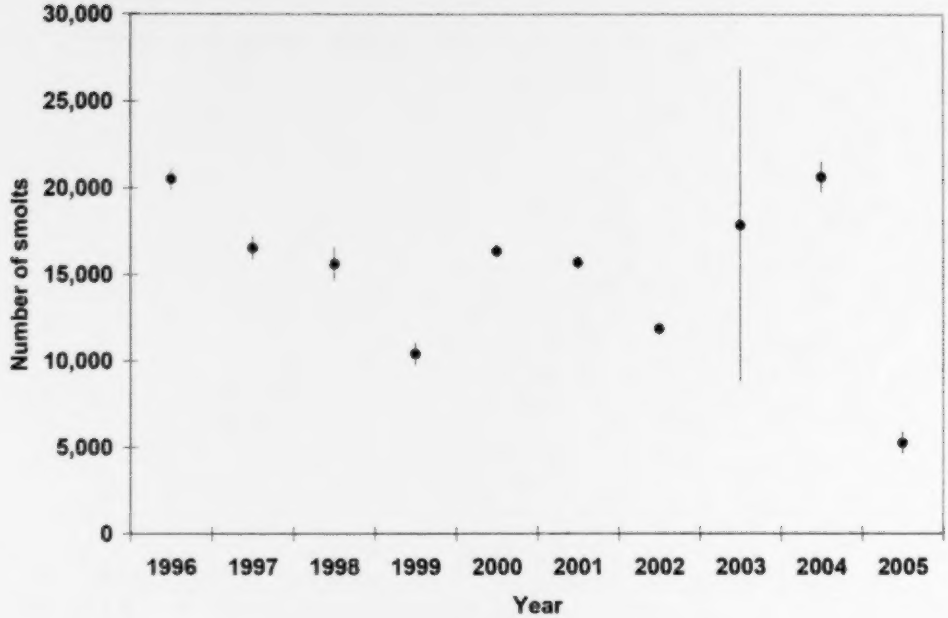

Figure 18. The estimated number (points) of outward-migrating, wild smolts passing through the Morgan Falls fishway in the years 1996 – 2005. Vertical bars show the 90% confidence interval of the estimate.

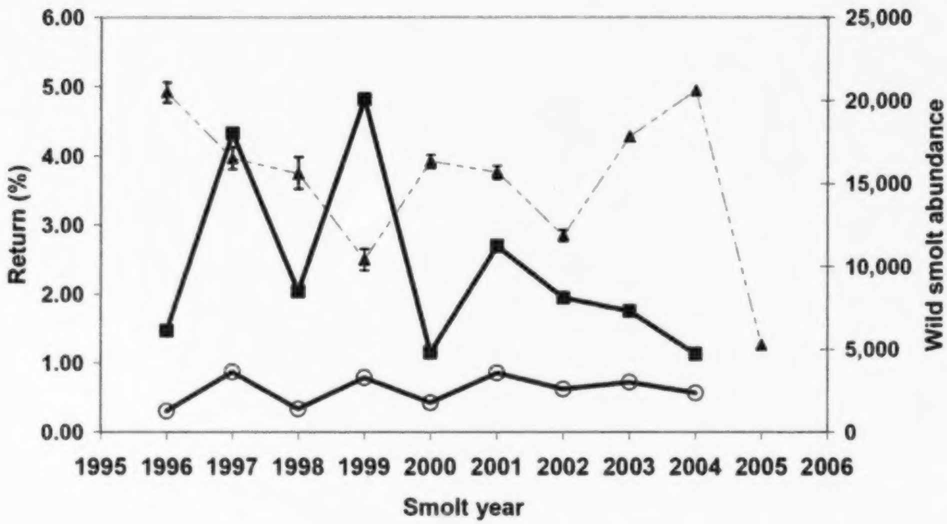

Figure 19. The estimated return rate of 1SW adult salmon of hatchery origin (open circles) and wild salmon (closed squares) as a result of estimated wild smolt abundance (closed triangles, dashed line) in the same year at Morgan Falls on the LaHave River.

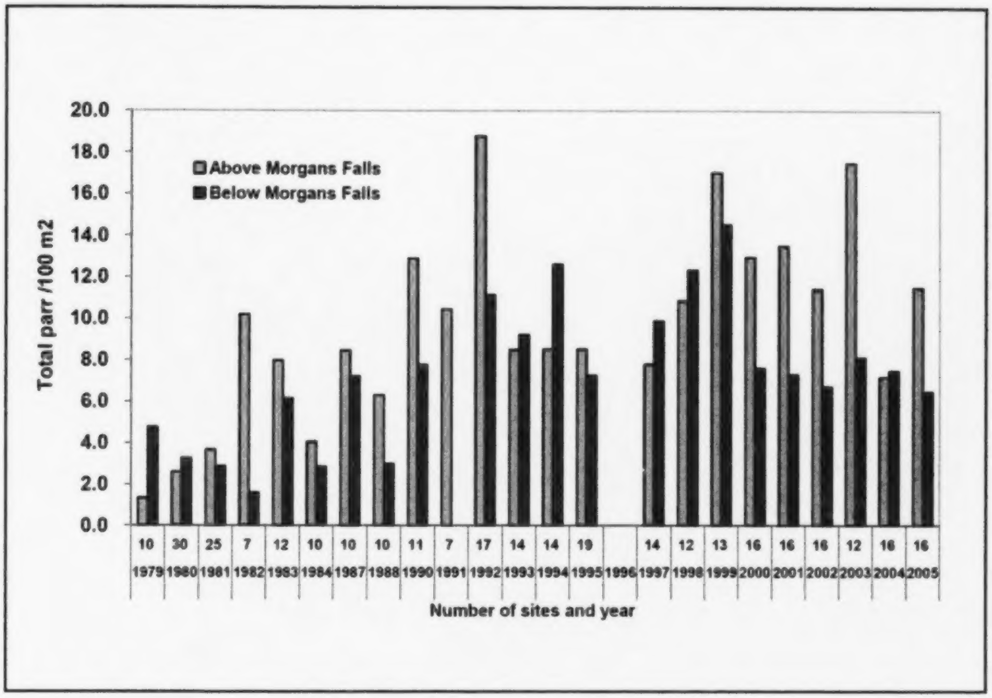

Figure 20. Mean juvenile salmon density above (light grey bars) and below (dark grey bars) Morgan Falls on the LaHave River in 1979 - 2005. Of the 16 sites monitored in 2005, 7 were above and 9 were below Morgan Falls.

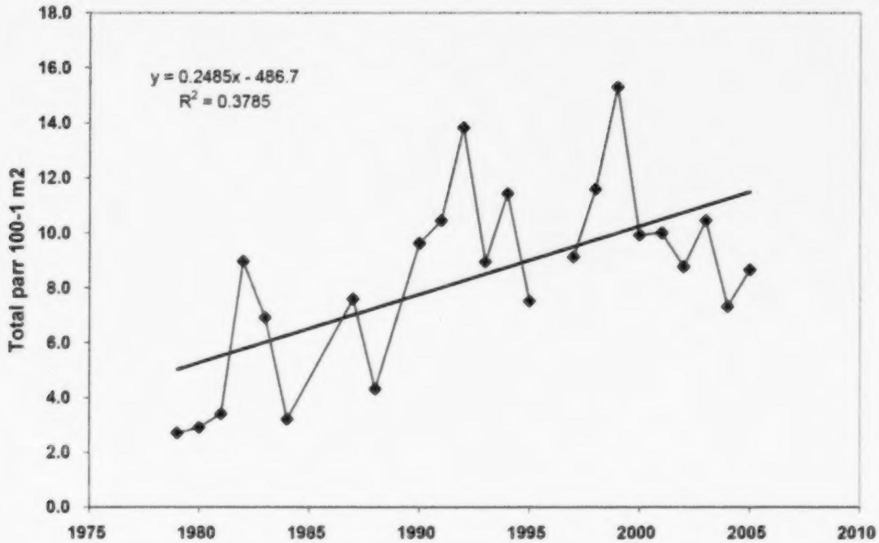

Figure 21. Estimated parr density (age-1 and age-2 combined) from the entire LaHave River (above and below Morgan Falls) from 1979 to 2005. The predicted relationship is based on a linear regression, where the equation as well as the R^2 value is given. Although parr density appears to be increasing slightly over time, the trend is not significant (p-value = 0.23).

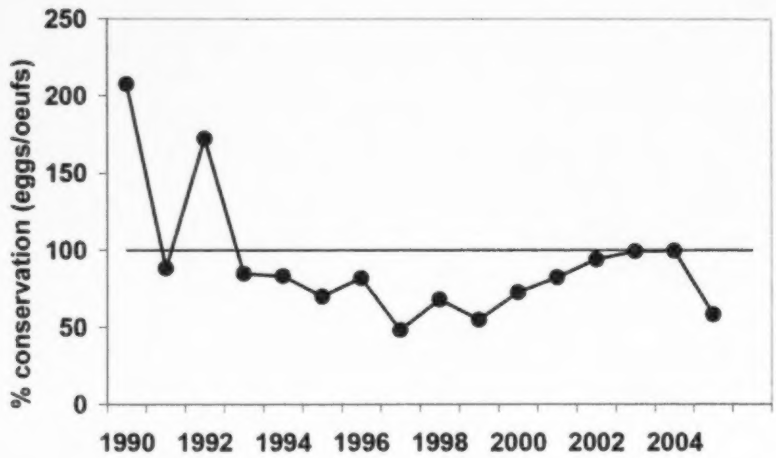

Figure 22. The percentage of the conservation requirement (1.9 million eggs) met above Morgan Falls on the LaHave River as estimated from the annual (1990 – 2005) escapement of wild and hatchery adult salmon.

Appendix 1. Summary of diver counts done in 2004 and 2005 on the Middle, Baddeck, and North Rivers. For visual representations of the numbered river sections, refer back to Figure 3 for Middle River, 5 for Baddeck River, and 9 for North River. For earlier data (prior to 2004) see Robichaud-LeBlanc & Amiro (2004).

Year	River	Dates M/R	Swim conditions	River section	Tags applied (M) 1SW	Tags applied (M) MSW	Tags applied (M) Total	Tags recovered (R) 1SW	Tags recovered (R) MSW	Tags recovered (R) Total
2004	Middle	Oct. 8	Guage at 1.8 feet	1					1	1
		Oct. 20	Partially sunny	2	2	6	8			
				3	2	7	9		7	7
				4					1	1
				Total			17			9
								Recovery rate = 0.53		
					Diver count **C** = 206; **M** = 17; **R** = 9					
					Grilse (36/170) = 0.21 of total					
2005	Middle				No tags applied					
		Nov.2	Gauge at 1.8 feet							
			Good visibility							
			drizzle and 100% cloud cover		Diver count C = 274					
					Grilse (57/274) = 0.21 of total					
2004	Baddeck	Oct. 21	very few fish holding in pools		Insufficient tags applied for mark-recapture					
		Oct. 21	Guage 1.7 feet		**M** = 3; **R** = 1					
					Diver count **C** = 56					
					Grilse (18/38) = 0.47 of total					
2005	Baddeck				No tags applied					
		Nov.1	Gauge at 1.9 feet							
			Good visibility							
			Sunny		Diver count **C** = 155					
					Grilse (34/155) = 0.22 of total					
2004	North	Oct. 21			No tags applied					
		Oct. 22								
					Diver count **C** = 98					
					Grilse (30/98) = 0.31 of total					
2005	North				No seining conducted					
					No diver conducted					

Appendix 2. Annual numbers of smolts stocked above and below Morgan Falls (1971 – 2005). The enhancement program was discontinued in 2003 and the last hatchery-reared smolts were released into the LaHave River in 2005.

	Above Morgan Falls								Below Morgan Falls							
	0+ Parr	1+ Parr		1+ Smolt		2+ Smolt		Total released above	0+ Parr	1+ Parr		1+ Smolt		2+ Smolt		Total released below
Year of Release		Untagged	Tagged	Total Released	Tagged	Untagged	Tagged			Untagged	Tagged	Untagged	Tagged	Untagged	Tagged	
1971		9,440		4,892	4,892			14,332	No Stocking Below Morgan Falls							
1972		6,790		8,400	8,400	6,450	5,000	21,640	" " " " "							
1973	51,643	43,133		9,166	4,970	18,526	7,971	122,468	" " " " "							
1974		3,735		19,815	9,958	14,435	5,890	37,985	" " " " "							
1975		18,883	13,963					18,883	" " " " "							
1976		6,875		45,259	9,954	5,769	3,990	57,903	" " " " "							
1977		44,314		74,577	16,031	5,370	2,000	124,261	" " " " "							
1978		7,108		72,067	48,832			79,175	" " " " "							
1979	30,753			33,910	19,942			64,663	" " " " "							
1980	10,626			62,225	11,651	16,039	5,998	88,890	" " " " "							
1981				25,482	8,078			25,482	" " " " "							
1982	NO STOCKING OF HATCHERY REARED FISH IN THE LAHAVE RIVER IN 1982															
1983				28,451				28,451				52,803	28,227			52,803
1984	32,900			15,000	15,000			47,900	11,501			36,002	12,000			47,503
1985	10,804			4,996	4,996			15,800	28,106			37,827	2,995			65,933
1986	55,722			16,864	16,864			72,586	16,995			83,334	4,986			100,329
1987	19,650			33,353	5,240			53,003	23,720			48,888	5,228			72,608
1988	42,481			16,018	9,616			58,499	90,470			28,676	9,631			119,146
1989				30,004	7,804			30,004	53,059			19,701	2,759			72,760
1990	82,432			15,970	4,999			98,402	83,484			26,980	9,999			110,464
1991	83,223			21,943	5,001			105,166	90,370			21,929	10,003			112,299
1992	48,587			27,516	8,000			76,103	40,096			26,006	4,001			66,102
1993	44,512			19,748	8,000			64,260	55,568			49,394				104,962
1994	34,827			26,110	7,999			60,937	29,250			36,071				65,321
1995				19,155	8,000			19,155	72,200							72,200
1996				49,526	5,940			49,526	40,703							40,703
1997				25,261	3,969			25,261	46,400			20,524				66,924
1998				45,695	3,996			45,695	20,508							20,508
1999				41639	3998			41,639	85273							85,273
2000				50,108	19,998			50,108	72,355			7878				80,233
2001				93,543	17,659			93,543	72,152							72,152
2002				36,737	18,789			36,737	63,382							63,382
2003				50,870	6,000			50,870	20,887							20,887
2004				36,219	3,999			35,538	8,000			681				8,681
2005				1,880	1,050			1,880								